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RDT&E Project No. 1G564605D410
USATECOM Project No. 1-VC-019-113-002
Report No. APG-MT-3280

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FINAL REPORT ON

ENGINEERING TEST

OF

RECOVERY VEHICLE, FULL-TRACKED,

LIGHT ARMORED (M113A1)

XM806E1

BY

HERMAN J. RAMIG

AUGUST 1969

FOR INFORMATION ONLY
ACTION BY HIGHER HEADQUARTERS PENDING

ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND

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The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents issued and approved by the Department of the Army.

(3) Page IV-7. Three shock absorbers replaced because of damage or leakage.

(4) Page IV-7. Drive sprocket teeth worn.

(5) Page IV-7. Excessive back lash between generator drive pully and shaft.

(6) Page IV-7. All rubber worn from roadwheel.

(7) Page IV-8. Dirt on bearing surface allowed roadwheel housing seals to leak.

(8) Page IV-9. Right headlight beams burnt out and lens cracked.

SHORTCOMINGS

The following shortcomings are not related to the vehicle recovery kit or auxiliary crane:

a. Reference Appendix II, Final Report of Service Test of Recovery Vehicle Full-Tracked, Light Armored (M113A1), XM806E1, USATECOM Project No. 1-VC-019-113-004 (formerly 1-7-2625-34), US Army Armor and Engineer Board dated 31 July 1969.

(1) Par 2.1. The seals on four left side road wheels leaked.

(2) Par 2.4. Inspection windows in the road wheel access hubs were pushed in allowing oil to leak around O-ring seal.

(3) Par 2.5. The track block outer section broke at both web sections.

(4) Par 2.6. Oil leaked at the return line elbow from the oil cooler to the crankcase.

(5) Par 2.8. The shock absorber mounting pins on the right front and right rear road wheel support assembly wore out.

(6) Par 2.9. Right rear idler wheels bent.

(7) Par 2.10. The wear plates on the right and left rear road wheels wore out.

(8) Par 2.13. The final drive outer seal was leaking and the outer bearing inner race was chipped.

(9) Par 2.14. Left front torsion bar broke on two occasions.

(10) Par 2.15. Oil leaked around the rocker arm cover gasket.

b. Reference Appendix IV, Final Report of Engineering Test of Recovery Vehicle, Full-Tracked, Light Armored (M113A1), XM806E1, USATECOM Project No. 1-VC-019-113-002 (formerly 1-7-2625-09), Aberdeen Proving Ground, dated August 1968.

(1) Page IV-7. Cooling fan drive belts failed.

(2) Page IV-7. Right number one torsion bar failed.

DEPARTMENT OF THE ARMY
HEADQUARTERS. U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-BB

2 3 SEP 1969

SUBJECT: Report of Engineering and Service Tests of Recovery Vehicle, Full-Tracked, Light Armored (M113A1), XM806E1, USATECOM Project Nos. 1-VC-019-113-002/-004 (Formerly 1-7-2625-09/-34)

Commanding General
U. S. Army Materiel Command
ATTN: AMCRD-GV
Washington, D. C. 20315

1. References.

a. ENSURE requirements 56 and 134.

b. RDT&E Project No. 1G564605D410

2. Approval Statement. Subject report is approved except as stated herein.

3. Background of Test.

a. ENSURE 56 describes the requirement for a recovery vehicle kit for the M113 armored personnel carrier. An auxiliary crane was also proposed as an accessory item. The vehicle was designated the XM806 and subjected to a military potential test. ENSURE 56 was subsequently expanded (ENSURE 134) to include the installation of the vehicle recovery kit on the M113A1. The nomenclature of Recovery Vehicle, Full-Tracked, Light Armored (M113A1), XM806E1, was assigned to this vehicle. The XM806E1 is designed for the recovery of disabled vehicles comparable in weight to the M113A1.

b. Test items include the vehicle recovery kit and an auxiliary crane adapted to the M113A1 armored personnel carrier.

(1) The vehicle recovery kit mounted in the personnel compartment, consists of components and support member for a hydraulically driven, 2-speed, 20,000 pound single line pull winch; a self-aligning fairleader with a cable tensioner; manually operated spades hinged to the rear of the vehicle; protective guards; recovery tools and equipment; and storage facilities. The winch can be operated with the ramp opened or closed.

(2) The auxiliary swivel mounted crane is bolted to the top of the hull, may be rotated 360°, and has a capacity of 3000 pounds. A manually pumped hydraulic cylinder, located on the side of the crane, operates the crane. A hinged base permits the crane to be lowered to a horizontal position against the top deck when not in use.

c. The objective of the test was to determine the suitability for US Army use of the vehicle recovery kit and auxiliary crane when installed on the M113A1.

d. Specific requirements or specifications for the XM806E1 were not established. Applicable portions of the Military Specifications for the M113A1 Armored Personnel Carrier and the Purchase Description for the XM806E1 were used for the evaluation. Tests were not conducted on the XM806E1 in those areas where there was no design change from the basic M113A1 and where the addition of the recovery kit or auxiliary crane would not have any effect on the test results.

e. The engineering test, conducted at Aberdeen Proving Ground, Maryland, included 4035 vehicle miles, 100.9 winch hours and 12 crane hours. The service test, conducted by the Armor and Engineer Board, Fort Knox, Kentucky, included 4001 vehicle miles, 100 winch hours and 12 crane hours.

4. <u>Test Results</u>.

a. The addition of the recovery equipment did not adversely affect the performance, handling or amphibious capabilities of the standard M113A1. Of the four deficiencies and 66 shortcomings initially reported, three deficiencies and 48 shortcomings involved the vehicle recovery kit or auxiliary crane. The remainder were failures of the basic vehicle (M113A1) which were not attributed to the addition of the recovery kit or auxiliary crane. Of the three deficiencies involving the vehicle recovery kit or auxiliary crane, one was corrected during the test and one is reclassified as a shortcoming by this headquarters. The three deficiencies, 49 shortcomings, plus the corrected deficiency are noted in succeeding paragraphs and inclosures.

(2) The auxiliary swivel mounted crane is bolted to the top of the hull, may be rotated 360°, and has a capacity of 3000 pounds. A manually pumped hydraulic cylinder, located on the side of the crane, operates the crane. A hinged base permits the crane to be lowered to a horizontal position against the top deck when not in use.

c. The objective of the test was to determine the suitability for US Army use of the vehicle recovery kit and auxiliary crane when installed on the M113A1.

d. Specific requirements or specifications for the XM806E1 were not established. Applicable portions of the Military Specifications for the M113A1 Armored Personnel Carrier and the Purchase Description for the XM806E1 were used for the evaluation. Tests were not conducted on the XM806E1 in those areas where there was no design change from the basic M113A1 and where the addition of the recovery kit or auxiliary crane would not have any effect on the test results.

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AMSTE-BB 23 SEP 1969
SUBJECT: Report of Engineering and Service Tests of Recovery Vehicle, Full-Tracked, Light Armored (M113A1), XM806E1, USATECOM Project Nos. 1-VC-019-113-002/-004 (Formerly 1-7-2625-09/-34)

would not hold in a descending attitude on the 30% slope with a loaded M113A1 in tow. Stopping distance with a vehicle in tow was twice that, for the same road speed and conditions, of the basic vehicle with no towed load.

b. In an ambient temperature of +120°F, only a 200 foot cable-length recovery at 50% of maximum rated load could be completed before the hydraulic fluid reached the maximum operating limit. However, 50% of maximum rated load is considered representative of line pulls expected to be experienced in the field.

c. The medium duty tow bar was not compatible with the tow connections on the 1/4 ton, 3/4 ton and 2 1/2 ton trucks. While this was not specifically required, it is highly desirable that the modification be made.

6. Conclusions. The vehicle recovery kit and auxiliary crane will be suitable for army use to meet the ENSURE requirement when the one deficiency and as many of the shortcomings pertaining to it as practicable are corrected.

7. Recommendations.

a. Although a warning is included in the vehicle publications, vehicle data plates and warnings in the operator's manual should also be provided to warn the vehicle crew of definite restrictions on speed in MPH during towing operations, precautions when descending slopes in excess of 20%, and restrictions in sighting and firing the weapon.

b. Winch quality control be improved.

FOR THE COMMANDER:

Raymond E Johnson
Col GS USA

3 incl
as (5 cys)

for: WILLIAM H. HUBBARD
Colonel, GS
Deputy Chief of Staff

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RDT&E PROJECT NO. 1G564605D410

USATECOM PROJECT NO. 1-VC-019-113-002

(4)

ENGINEERING TEST OF
RECOVERY VEHICLE, FULL-TRACKED,
LIGHT ARMORED (M113A1)
XM806E1.

(9) FINAL REP[redacted]RT, 17 [illegible]

BY

(10) HERMAN J./RAMIG

(11) AUG[redacted]69 (12) 172p.

(14) APG-MT-[illegible]

(16) RDT/E-1-G-564605-D-410,
USATECOM-1-VC-019113002

ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND
21005

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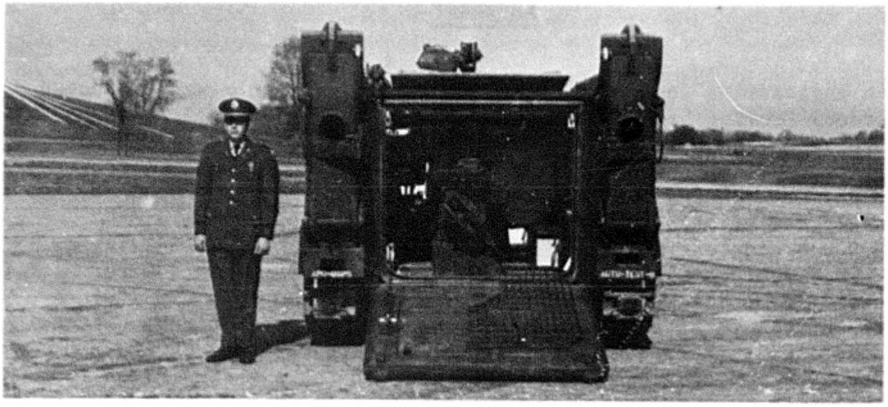
ABSTRACT

An engineering test of the XM806E1 recovery vehicle was conducted at Aberdeen Proving Ground (APG) from 17 December 1968 to 3 June 1969. The purpose of the t ` was to determine the performance, suitability, durability, safety, and maintainability of the vehicle; and whether or not any degradation was realized to the basic M113A1 armored personnel carrier. The vehicle was scheduled for operation at APG for 4000 vehicle test miles, of which 1000 were with an M113A1 in tow. Also, 100 winch operating hours and 12 crane operating hours were conducted. Poor quality in manufacturing was responsible for a winch gear-train failure after 59.8 winch hours. Several additional defects were disclosed that were a recurrence of defects reported during the M113 recovery vehicle test. The durability of the standard M113A1 tow pintle was unsatisfactory for the towing test phase. An M548-type pintle was later evaluated for 1000 miles and found satisfactory. Operational hazards were disclosed for vehicle operation with an M113A1 in tow. It was recommended that the operator be warned of possible operational hazards. It was further recommended that winch quality-acceptance standards be increased.

FOREWORD

Materiel Test Directorate was responsible for preparing the test plan conducting the test, and preparing the test report.



PHYSICAL DATA

- Weight, curb (with fuel, OVE) ----------- 24,500 lb
- Payload (driver, 2 crewmen) ------------- 720 lb
- Length (spades in travel position) ------- 210 in.
- Width ------------------- 105 in.
- Height (spades in travel position) -------- 96 in.
- Ground clearance ---------- 15 in.

POWER PLANT

- Engine --------------------- 6V53
  - Displacement -------- 318 cu in.
  - BHP ---------------------- 210
  - Fuel ------------------ Diesel
- Fuel capacity
  - Total -------------- 95 gal (D)
  - Usable --------------- Untested

POWER TRAIN

- Transmission --- Model TX100-1 Automatic, 3 speeds forward, 1 speed reverse
- Transfer gear case -------- ratio 1.1.286 (D)

BODY/HULL

- Type, welded aluminum plate
  - Cargo floor size --------- None
  - Crew -------- Driver, 2 crewmen

SUSPENSION

- Type, torsion bar
  - Tracks -- Type T-30, single pin with detachable rubber pads, 15 in. wide
  - Road wheels ----- 20 (10 duals)
  - Ground pressure ------- 7.8 psi
  - Tread (centerline to centerline of tracks) ---------- 85 in. (D)

STEERING

- Type, controlled differential turning diameter
  - Wall to wall -------- 46.5 ft
  - Swimming ---------- Untested

ELECTRICAL SYSTEM

- Type ---- 6 TN battery, 24 volts, 100 amp

ARMAMENT

- Machine gun --------- Cal .50, M2
- Rifle ---------- 7.62-mm, M14 (2)

AMMUNITION

- 200 rounds, cal .50

FIRE CONTROL AND VIEWING DEVICES

- Periscope, M17
  - Driver's hatch ------------- 4
  - Commander's cupola ---------- 5
  - Spare (stowed) ------------- 1
- Periscope, M19
  - Stowed -------------------- 1
  - Spare head (stowed) --------- 1

PERFORMANCE

- Max speed (land) --------- 41 mph
- Max speed (water) ------- 3.2 mph
- Max gradeability ------------ 60%
- Side slope ----------------- 30%
- Fording depth -------- Amphibious
- Vertical step ------------ 30 in.
- Trench crossing ---------- 72 in.
- Cruising range ---- 200 miles (D)

AUXILIARY EQUIPMENT

- Intercom --------------- AN/VIC-1
- Radio ---- AN/GRC-3 through 8, or AN/VRC-8 to 10, or AN/VRC-24, or AN/GRC-19, or AN/VRQ- 1 through 3, or AN/PRC-8 through 10, or AN/GRR-5, or combinations of these and other standard radio sets

WINCH KIT

- Winch --------------- Model P.30
  - Cable --- 300 ft, 5/8-in. diam
  - Hydraulic tank
    - Usable capacity --- 30 gal (D)
    - Type fluid ------ MIL-H-6083
  - Hydraulic pump
    - flow rate ------ 1000 psi at 1200 rpm 16.4 gpm
  - Line speed, pay-in, max
    - Low gear, no load --- 53 fpm
    - Low gear, 90% max load ---------- 23 fpm
    - High gear, no load ------------ 231 fpm
    - High gear, 90% max load --------- 121 fpm
    - Angular pull, max
      - Ramp down
        - Left of winch centerline ---- 46 deg
        - Right of winch centerline ---- 51 deg
      - Ramp up, access door open
        - Left of winch centerline ---- 46 deg
        - Right of winch centerline 10.5 deg
    - Line pulls, max range
      - Empty drum, low gear --------- 20,900 lb
      - Full drum, high gear ---------- 3,150 lb
    - Brake capacity
      - Full drum line pull ----- above max pull
    - Spades, side (2) with attachable center, manual

CRANE KIT

- Crane, model MC-3000, manual
  - capacity
    - 45 in. boom -------- 4000 lb
    - 60 in. boom -------- 3000 lb
  - Rotating base -------- 360 deg
  - Azimuth locking
    - intervals ----------- 45 deg

Data Compiled: January 1969

Characteristic Photograph

ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND 21005

USATECOM PROJECT NO. 1-VC-019-113-002

FINAL REPORT ON ENGINEERING TEST OF
RECOVERY VEHICLE, FULL TRACKED, LIGHT
ARMORED (M113A1) XM806E1

17 DECEMBER 1968 TO 3 JUNE 1969

SECTION 1. INTRODUCTION

1.1 BACKGROUND

A military potential test of the recovery kit and crane for the M113 armored personnel carrier was conducted at Aberdeen Proving Ground from April to September 1968 (Reference 3). The conclusions indicated that the addition of the kit did not adversely affect performance or durability of the basic carrier; however, the durability of the recovery components needed improvement to meet the 100 winch hour operation requirement.

Based on the relative success of the M113 test vehicle, a decision was made to install a recovery kit and crane on a M113A1 (diesel version of the M113). One M113A1 with recovery kit and crane was sent to APG for an engineering test and another sent to the US Army Armor and Engineer Board (USARENBD) for service test since type-classification of the diesel version is currently planned.

1.2 DESCRIPTION OF MATERIEL

The XM806E1 recovery vehicle is an M113A1, APC modified for the recovery of disabled vehicles comparable in weight to the M113A1.

The recovery equipment consists of components and support members for a hydraulically driven winch, a self-aligning-fairleader with a cable tensioner, a boom-type crane, and two ground spades hinged to the rear of the vehicle, one on each side of the ramp. The spades stabilize the vehicle to allow a greater winch line pull. A crew of three operate the recovery vehicle and its equipment.

The hydraulically powered winch is a 2-speed planetary reduction unit located in the personnel compartment. The winch is bolted to a subframe which, in turn, is welded to the vehicle floor. The winch includes a level-wind assembly to assure proper stacking of the cable.

The winch is designed to exert a maximum single-line pull of 20,000 pounds; overload is prevented by an integral relief valve in the winch-control valve. A fairleader and tensioner is bolted to the modified vehicle floor framing to the rear of the winch. The fairleader serves to guide the winch cable while the tensioner prevents cable fouling on the winch drum. Operation is by a single control in the cargo area. The winch and cable areas are shrouded by guards to protect the operator and crew from cable whiplash.

Two open-mesh gates are installed in the ramp opening. The guards allow the operator to observe recovery operations and remain protected. The cable may also be operated through the personnel door with the ramp raised for additional armor protection during combat retrieval operations.

The auxiliary, swivel-mounted crane is bolted to the top of the hull and may be turned 360°. A manually-pumped hydraulic cylinder, located on the side of the crane, operates the crane. A hinged base permits the crane to be lowered to a horizontal position against the top deck when not in use. Maximum capacity of the crane is 4000 pounds.

As a result of the military potential test and the physical differences between the gas and diesel versions of the M113, the following major changes appear on the M113A1:

a. Relocated hydraulic pump and mount.

b. Rerouted hydraulic lines in the engine compartment.

c. Revised remote throttle linkage and idle no-load adjustment.

d. Additional hull support for the winch mount.

e. Reduced eccentricity of level-wind trunnion caps and increased relative angle.

f. Added hydraulic pressure and temperature gages and warning light (+160°F) on the reservoir.

g. Added safety gate over the upper half of the left side of the ramp opening hinged along the left side.

h. Revised center-spade-to-spade attachment.

i. Added tab locks to crane base-mounting bolts.

j. Added tow cable bridle to OVE.

k. Modified winch operation lever so that the fairleader cheater bar may be used for extended periods of winch operation.

l. Relocated stowage provisions for the snatch blocks, crowbars, tow cable, intercom, center spade, left rifle-mounting bracket, and left fire extinguisher.

m. Chromeplated level-wind floating-pulley shaft for improved lubrication.

1.3 TEST OBJECTIVES

The objectives were to determine the following:

a. Performance, functional suitability, durability, and maintainability of the vehicle recovery kit and crane.

b. Effects of vehicle recovery kit and crane on basic chassis durability, performance, and amphibious capabilities.

c. Utility of layout and configuration of crew compartment; adequacy of recovery tools and equipment and stowage provisions.

d. Any possible safety hazard or adverse human factors associated with the design of the XM806E1 recovery vehicle.

e. Adequacy of maintenance package.

1.4 SUMMARY OF RESULTS

Gross weight of the test vehicle was approximately 1000 pounds greater than a standard M113A1; nonetheless, the performance and handling characteristics were comparable to a standard M113A1 APC.

The winch performance characteristics provided a single-line pull in low gear on the bare drum of 20,900 pounds. All winch performance characteristics were satisfactory.

Mission capabilities of the test vehicle were satisfactory. Under varying terrain conditions, the vehicle was able to recover a disabled vehicle of similar weight without difficulty. The cable bridle enhanced the recovery versatility of the test vehicle.

An operational limitation disclosed during the test was the hydraulic-oil temperature increase in high ambient-temperature environments. Functional recovery tests indicated that 50% of the maximum rated load was representative of line pulls actually expected to be experienced in the field. In an ambient of +100°F, two full cable-length retrievals could be accomplished at 50% of the rated load; however, in an ambient of +120°F a complete full cable-length recovery, at 50% load, could not be completed before the hydraulic fluid reached the maximum operating limit.

The standard M113A1 towing pintle was not sufficiently durable to withstand the loadings imposed during towing operations. A larger tow pintle (M548 type) was installed and found satisfactory for 1024 miles of towing operation.

Several towing operational hazards were disclosed. Steering control became hazardous when decending a 30% longitudinal slope with a loaded M113A1 in tow. With a fully loaded M113A1 in tow, the test vehicle brakes would not hold in a descending attitude on the 30% longitudinal slope and the stopping distance was twice that for the same road speed and conditions as the basic vehicle.

Additional operational hazards were realized by the firing restriction imposed with the side spades in the travel position.

Winch gear-train failure from poor quality control of material properties was the only deficiency reported during the test. The gear failure occurred after 59.8 winch hours.

Several defects were disclosed that were a recurrence of defects reported during the M113 recovery vehicle test: Leaking counterbalance valve; vehicle fender cracks; levelwind floating-pulley spoke cracks; fairleader hull-mount cracks; bolt loosening of the recovery components; fairleader-tensioner handle enterference with the mount; and levelwind trunnion-cap setscrew failure.

The vehicle-mounted crane was satisfactory for removing and reinstalling the power package from an M113A1 vehicle. Operator fatigue was noted during raising of maximum capacity loads.

Maintainability characteristics of the test vehicle were similar to those of the basic M113A1 vehicle; scheduled maintenance requirements, however, were higher than those of the basic APC because of the care required for the winch cable.

The stowage facilities were satisfactory.

1.5 CONCLUSIONS

It is concluded that:

a. The addition of recovery equipment did not adversely affect the performance, handling or amphibious capabilities of the standard M113A1. Durability of the basic vehicle chassis experienced some degradation, disclosed by the appearance of fender cracks (ref par. 2.22).

b. Although the vehicle was unable to complete a 50% rated load full-length cable-recovery operation in a +120°F ambient environment, the vehicle could perform 50% rated load, 200-foot recovery in a +120°F ambient environment (ref par. 2.17).

c. Quality control of winch components was unsatisfactory (ref par. 2.17).

d. Operational caution must be exercised when performing towing operations (ref pars. 2.8 and 2.16).

e. The durability of the standard M113A1 tow pintle was unsatisfactory for cross-country towing operations; the M548 type pintle was sufficiently durable (ref par. 2.19).

f. The crew-compartment configuration was suitable (ref par. 2.21).

g. The maintenance package was incomplete since parts and maintenance manuals were not provided, and the operator's manual did not warn of towing and weapon-firing operational hazards (ref par. 2.6).

1.6 RECOMMENDATIONS

It is recommendated that:

a. The vehicle crew be informed of weapon firing interference and towing hazards, provided in the form of appropriate vehicle data plates and warnings in the operator's manual.

b. Winch quality-acceptance standards be re-evaluated and increased.

c. The M548 tow pintle be incorporated as part of the basic M113A1 modifications for production of the XM806E1.

d. Complete maintenance and operational manuals be evaluated.

SECTION 2. DETAILS OF TEST

2.1 INTRODUCTION

All testing described in this report was conducted at Aberdeen Proving Ground, Maryland in accordance with Reference 5. Formalized test criteria were limited since there were no QMR's, SDR's, or TC's on the test item. Where applicable, test results were compared with performance of the basic M113A1, APC, and the M113 with the recovery kit (References 1, 3, and 4).

The purchase description for the XM806E1 (ATPD-2033A, dated 19 May 1969) was made available after the conclusion of the test. Test results were compared to the ATPD requirements as applicable.

A liaison was maintained with USATACOM regarding defects that occurred during the test. As a result, USATACOM issued Engineering change-proposals (ECP) - Engineering Orders (EO) to correct the defects on future vehicles. The ECP - EO's which have been originated are reported in the applicable subtest which discusses a particular defect.

The payload where appropriate was simulated, during these tests, by sandbags located in a manner to provide the proper weight distribution. The installed load was of an amount that represented personnel, their equipment, and any other equipment not actually installed. A weight of 240 pounds was used to simulate the weight of a crew member, as defined in FM 57-35.

An instant-start - instant-stop hourmeter was installed to record elapsed time for winch operation, i.e. when the winch drum was actually rotating.

Two thermocouples and one pressure gage were installed to record temperature and pressure during winching operations. The thermocouples were installed in the hydraulic reservoir and in the winch motor gear case. The pressure gage was installed in the main inlet line to the control valve.

All fuels and lubricants were standard military types, normally available to operating units and were used in accordance with lubrication order 9-2300-224-12/2 and the manufacturer's supplemental publication.

Photographs of failed parts and vehicle problems were made. Characteristic and general-view photographs of the vehicle were taken. Random-footage motion pictures were taken during testing.

2.2 INITIAL INSPECTIONS AND SERVICING

2.2.1 Objective

The objective was to assure that the vehicle was in good mechanical condition and that major component serial numbers and pretest data were recorded prior to start of the test program. Base line conditions were used to assure adequacy of test results and quality of materials.

2.2.2 Criteria

Criteria are as follows:

a. Appropriate Department of the Army technical manuals, lubrication orders, and manufacturer's publications are used to assure good condition and adequate lubrication.

b. M113A1 military specification, Reference 1, par. 3.4.

c. XM806E1 ATPD, Reference 2, par. 3.4.

2.2.3 Method

A limited technical inspection was performed noting the initial condition of components. Major component serial numbers were recorded (MTP 2-2-502).

All fluid systems and lubrication points were fully serviced with the proper fuels, lubricants and fluids (MTP 2-2-503).

2.2.4 Results

The major component serial numbers of the XM806E1, USA Reg No. 12C27468, are listed in Table 2.2-I.

Table 2.2-I. Major Component Serial Numbers

Component	Serial No.
Engine	6D39558
Transmission	7T5761
Differential	6505
Transfer case	4843

The vehicle arrived with an odometer reading of 140 miles and engine hourmeter reading of 11.0 hours. There were no records of winch or crane operation accumulated prior to receipt of the test vehicle.

The vehicle was serviced according to lubrication order 9-2300-224-12/2 and the manufacturer's supplemental publication using standard military lubricants.

The remote throttle control was improperly set. The linkage was adjusted to provide a 1500 to 1800 rpm engine speed at full throttle setting (EPR K2-4).

The crane utility release valve was bent during shipment. The valve was replaced to eliminate hydraulic fluid leakage (EPR K2-3).

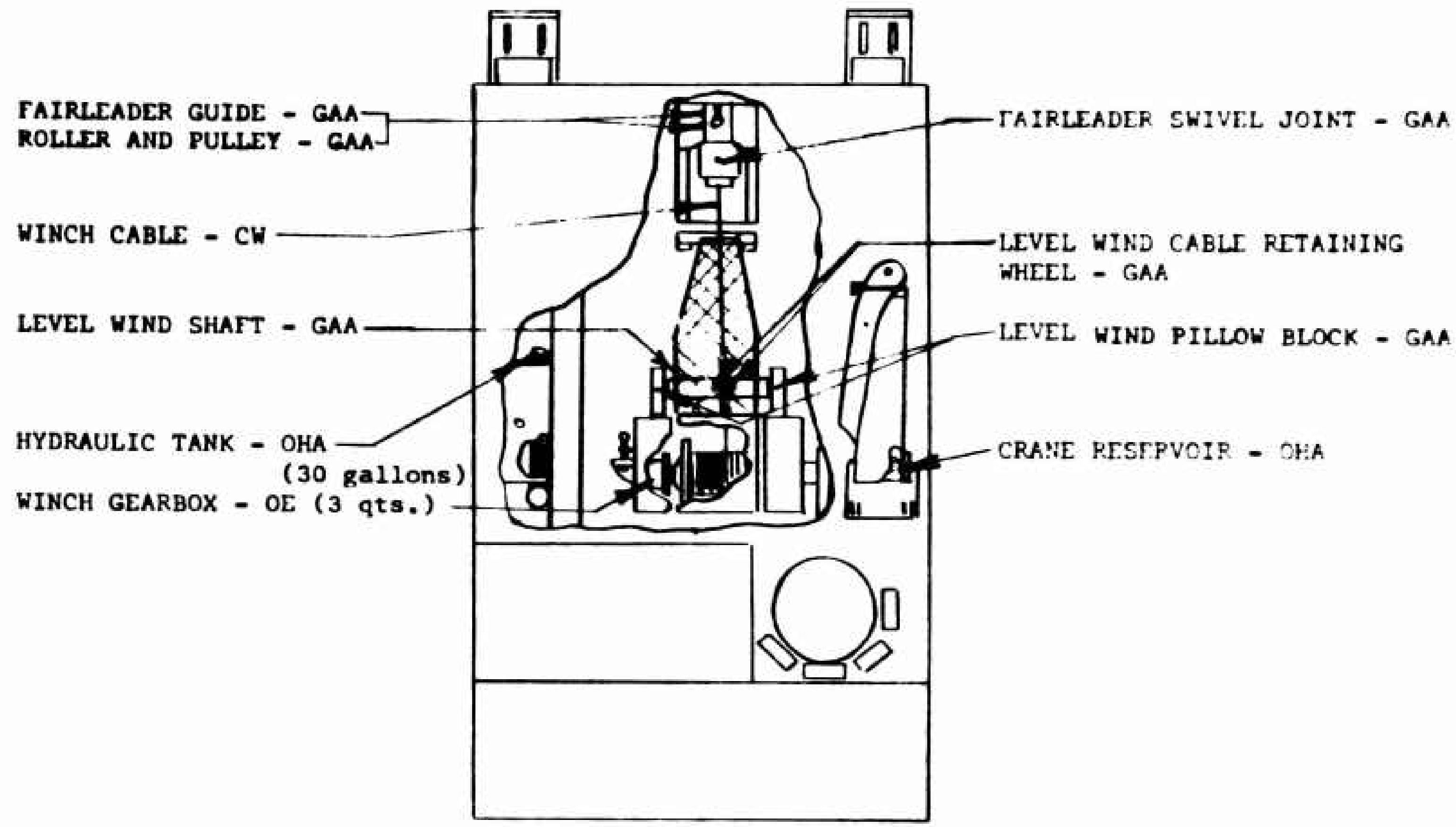
The lubrication points of the winch and crane are shown in Figure 2.2-1. The basic vehicle lubrication remains the same as for the basic M113A1 carrier.

The winch-drum breather plug was located below the level plugs (EPR K2-51). The drum could not be filled with the necessary amount of lubricant until the breather plug was relocated above the level plugs.

2.2.5 Analysis

Except for the remote throttle-control setting, winch breather-plug location, and the damaged crane valve, the vehicle arrived in satisfactory condition.

The winch adapted for use in the XM806E1 is a standard military winch used in the M578 recovery vehicle. For the XM806E1 application, the breather plug must be relocated. This incident is identical to the occurrence reported during the M113 recovery vehicle test. The manufacturer should insure that the winch drums are properly modified for use in the XM806E1.



OE - Lubricating oil, enternal combustion engine (range: OE 30 to FS)
CW - Lubricating oil, chain-wire rope - exposed gear
GAA - Grease, automotive and artillery
OHA - Hydraulic fluid petroleum base

Figure 2.2-1: Lubrication Points for the Winch and Crane.

2.3 STOWAGE

2.3.1 Objective

The objective was to assure that all on-vehicle equipment (OVE) can be safely stowed in positions that provide proper utility for the crew without undue safety hazards, and to ascertain the reliability of the stowage fixtures, brackets, and straps.

2.3.2 Criteria

Criteria are as follows:

a. M113A1 military specification, Reference 1, par. 4.5.2.6.

b. XM806E1 ATPD, Reference 2, par. 3.4.12.

c. Comparison with M113 with recovery, Reference 3.

2.3.3 Method (MTP 2-2-802)

The OVE was stowed in designated positions and inspected for utility and safety. The OVE remained in position throughout the test to further observe reliability and durability of stowage fixtures and brackets.

The caliber .50 machine gun and the 7.62-mm rifles were replaced with demilitarized weapons. Ammunition boxes were filled with metal of a weight representative of fully loaded boxes.

2.3.4 Results

A list of OVE which was provided by the manufacturer and installed on the test vehicle is included in Table 2.3-I.

Table 2.3-I. OVE Installed on Test Vehicle

Qty	Item Nomenclature	Federal Stock No. (or Part Number)	Stowage Location
1	Mount, machine gun, caliber .50	1005-704-6650	On support arm commander's cupola.
1	Cover, spare barrel, machine gun, caliber .50	1005-796-4436	On spare barrel.
1	Mount, tripod, machine gun, caliber .50, M3, w/cover	1005-322-9716	On top deck rig.'t f cupola.
1	Bag, tool	5140-473-6256	On left rear sponson.
1	Can, water, military, 5 gal	7240-242-6153	Right side box beam (rear).
1	Adapter, grease gun, rigid thin stem, 6 in. long	4930-387-9551	In tool bag.
1	Oiler, hand, trigger type, 1 pint cap. 9 in. spout	4930-262-8868	Right side wall.
1	Cutter, bolt, rigid hand type, clipper cut type, 9/16 in. diameter mild steel rod cutting capacity, 35 to 39 in. long, OD finish	(MS16888-4)	Right rear side wall.
1	Hammer, hand, sledge, blacksmith's, double-faced, 20 lb, 34 to 37 in. long, OD finish	5120-230-7843	Top deck forward of cargo hatch.
1	Bar, pinch, off set and tapered ends, 1 in. hexagonal, 36 in. long, OD finish	5120-224-1384	Lower left side wall.
1	Bar, wrecking, goose neck and pinch, w/claw, 3/4 in. hexagonal, 36 in. long, OD finish	5120-242-0762	Lower left side wall.
2	Crowbar, pinch point, 1-1/4 in. diameter, 59 to 62 in. long, OD finish	5120-224-1390	Top deck right side.
1	Chisel, blacksmith's, cold, handled, 1-1/2 in. cutting edge, 16 in. handle, OD finish	5110-221-1075	Lower left side wall.
2	Chisel, machinist's, cold, handled, long length, 1 in. cutting edge, 24 in. long, OD finish	5120-238-8292	Lower left side wall.
1	Jack, hydraulic, handled, 8 ton capacity w/operator lever, OD finish	(MS16283-3)	In center stowage tray (handle in seat stowage box).
1	Saw, crosscut, 1-man, 4-1/2 ft blade, 5 ft long w/supplementary handle	5110-754-0704	Right side upper wall.
1	Case, crosscut saw, cotton duck, 63-3/4 in. long	2540-860-2354	On crosscut saw.

Table 2.3-I (Cont'd)

Qty	Item Nomenclaturer	Federal Stock No. (or Part Number)	Stowage Location
1	Tow bar assembly, medium duty	(F7263793)	Leg assembly on top deck, clevis assembly in center stowage tray.
2	Snatch block (10 ton), OD finish	(K11631726)	Lower left side wall.
1	Floodlight, electric, 24-volt	(MS51320-1)	In seat stowage box compartment.
9	Periscope, M17 (driver's and commander's)	6650-704-3549	Around driver's and commander's station.
1	Punch, blacksmith's, round, handled, 1/4 in. diameter cutting edge, OD finish	5120-197-9473	In tool bag.
1	Axe, single-bit, handle, 4 lbs, 36 in. long, OD finish	5110-293-2336	On top deck, rear center.
1	Mattock, pick-type, w/handle, 5 lbs	5120-248-9959	On top deck, rear center.
1	Shovel, handle, round point, long handle, blade 9-1/2 in. w/11-1/2 in. extension long, handle 46 in. long, OD finish	5120-293-3334	On top deck, right side.
1	Crowbar, pinch point, 1 in. by 48 in. long	5120-240-6040	On top deck, rear center.
1	Hammer, hand, sledge, blacksmith's, double-face, 6 lbs	5120-265-7462	On top deck, rear center.
2	Fixture, track connecting	5120-678-2793	On top deck, left rear.
1	Cable assembly, floodlight	(11646861)	On floodlight.
2	Sling, endless	(11646863-1)	In seat stowage box.
1	Chain, safety, ramp	(11647281)	In center tray rear.
1	Lever, fairleader	(11633885)	Right side of winch cable guard support.
1	Vise, bench and pipe swivel base, 4 in. jaw width 6 in. opening, 1/8 to 4 in. pipe capacity, OD finish	5120-293-1439	Right front exterior.
1	Hoist, chain, handle operator, 1-1/2 ton capacity, distance between hooks 16 in. retracted, minute lift 50 in.	(11640383)	In seat stowage box.
1	Cable, sling, utility, steel, 5/8 in. diameter	(11647282)	In center tray.

Table 2.3-1 (Cont'd)

Qty	Item Nomenclature	Federal Stock No. (or Part Number)	Stowage Location
1	Cable, tow, steel, 3/4 in. diameter by 10 ft long w/eyes	2540-767-3149	On ramp, outside vehicle.
2	Extinguisher, fire, CF, 3 BR, (Freon) handle, 2.75 lb capacity, OD finish	4210-555-8837	In brackets 10924916 1-right rear wall; 1-left side.
2	Anchor shackle, screw-pin, 2 in. box width, 3-1/4 in. inside length	Unknown	In center tray.
1	Grease gun, handle, high pressure, lever operated, 15 oz.	4930-253-2478	In tool bag.
1	Manual, technical (operator's)	TM 9-2300-224-10/2/1	In pamphlet bag.
1	Order, lubrication	LO 9-2300-224-10/2/2	In pamphlet bag.

The OVE arrived without a wrench (FSN 5120-224-3154) and a crowbar (FSN 5120-240-6040) (EPR K2-7). The radios and associated equipment were not received nor installed as per USATECOM test directive (Appendix VI).

The 1-1/2 ton capacity of the chain hoist was inconsistent with the 2-ton maximum capacity of the crane (EPR K2-8).

All the OVE was installed in the spaces provided without interference.

The rubber bumpers of the hook and damper assembly were not compressed sufficiently to rigidly secure the side spades in the travel position (EPR K2-14). Some wear was evident on the hook from spade vibration after 1423 miles of vehicle operation.

During vehicle operation, the center spade progressively slid rearward of the designated stowage position (EPR K2-87). The center section interfered with the rear lifting eye and a flat was worn on the spade.

2.3.5 Analysis

The test vehicle successfully met the criteria established by the M113A1 specification and the XM806E1 ATPD since the stowed items did not interfere with the operation of the vehicle and components. The stowage design for the center spade section could be improved by providing a rear stop to maintain the position of the spade.

Stowage positions provided for the XM806E1 were improved compared to the M113 recovery vehicle. The personnel compartment rifle stowage bracket and the fire extinguisher have been relocated out of the traffic pattern along the left side of the personnel compartment. The equipment congestion in the center stowage tray has been alleviated by mounting the two snatchblocks and crowbars on the left sponson.

The crane is to be provided with a data plate reducing the maximum allowable capacity to 3000 pounds (ECP/EO D9846). The intended crane-capacity limitation will insure compatability with the chain hoist.

2.4 PRELIMINARY OPERATION

2.4.1 Objective

The objective was to assure proper break-in of the various components and provide a period of familiarization for the operator prior to conducting additional tests and stress operations that will make inherent hazards or weaknesses apparent.

2.4.2 Criteria

Criteria are as follows:

a. Special training and familiarization of trained, professional drivers not required.

b. Proper and suitable functioning of all components.

c. Satisfactory control of vehicle operating functions.

d. M113A1 military specification, Reference 1, par. 3.5.5.

e. XM806E1 ATPD, Reference 2, par. 3.5

2.4.3 Method (MTP 2-2-505)

The vehicle with minimum specified load was operated on a gravel road (Munson test course) for a total of 50 miles in accordance with the following schedule:

a. Fifteen miles at 12 mph.

b. Fifteen miles at 20 mph.

c. Twenty miles at 30 mph.

After each division at the break-in run, the vehicle was stopped, the engine allowed to idle for not less than 2 minutes, and the vehicle driven in reverse for a distance not less than 50 feet

During this period of operation, the vehicle operator was afforded the opportunity to familiarize himself with any special operating requirements of the vehicle, winch, and crane. This operation was considered part of the endurance test.

The vehicle was operated without payload an additional 210 miles over paved and gravel roads, until the vehicle odometer reading was 400 miles.

2.4.4 Results

The vehicle performed satisfactorily during break-in operations.

2.4.5 Analysis

There were no indications of damaged components, maladjustment, or loss of orignial adjustment. The test vehicle successfully met the criteria established by the M113A1 military specification and the XM806E1 ATPD.

2.5 VEHICLE CHARACTERISTICS

2.5.1 Objectives

The objectives of this test were to record basic dimensions, data, and characteristics of the vehicle.

2.5.2 Criteria

Criteria are as follows:

a. M113A1 military specification, Reference 1.

b. XM806E1 ATPD, Reference 2.

c. Comparison with M113 recovery vehicle, Reference 3.

2.5.3 Method (MTP 2-2-500)

The specified dimensions were obtained and recorded upon receipt of the vehicle.

A complete list of pertinent characteristics of each component or major component group was prepared.

General-view photographs were taken and the characteristics photograph was made incorporating significant components and data.

Performance data were obtained from results of engineering tests and recorded as performance characteristics.

2.5.4 Results

The over-all dimensions of the test vehicle appear in Appendix I.

Photographs of the vehicle and recovery components are included in Appendix II.

Table 2.5-I includes pertinent characteristics of recovery components.

Table 2.5-1. Major Component Data of
XM806E1 Recovery Vehicle

Component	Characteristic
Winch, model P-30 modified with grooved sleeve	
Cable	300 ft, 5/8-in. diameter
Maximum single line pull	
Low gear, empty drum	20,000 lb
Low gear, full drum	14,800 lb
High gear, empty drum	4,950 lb
High gear, full drum	3,150 lb
Hydraulic tank, usable cap	30 gal (D)
Hydraulic pump, flow rate	1000 psi at 1200 rpm, 16.4 gpm (D)
Hydraulic pump speed	1335 rpm at 1500 rpm, engine speed (D)
Line speed, max, no load (2750 rpm engine idle)	
Low gear, empty drum	39 fpm
Low gear, full drum	53 fpm
High gear, empty drum	162 fpm
High gear, full drum	231 fpm
Maximum angular pull	
Ramp down	
Left of winch centerline	47 deg
Right of winch centerline	55 deg
Ramp up cargo, access door open	
Left of winch centerline	47 deg
Right of winch centerline	10.5 deg
Crane, model MC-3000	
Capacity	
45-inch boom	4000 lb
60-inch boom	3000 lb
Rotating base	360 deg
Azimuth-locking intervals	45 deg

(D) = Design.

2.5.5 Analysis

The addition of the recovery equipment to the basic M113A1 increased the over-all height of the basic vehicle by 22 inches with the spades in the travel position. The over-all length of the basic vehicle was increased by 19 inches because of the side spade standoffs.

The winch hydraulic system for the XM806E1 has been changed from the M113 recovery vehicle system by lowering the relief-valve pressure setting. Subsequently, the maximum line pulls on each spooling layer have been reduced. The difference in maximum line pulls is tabulated in paragraph 2.17.

The test vehicle met the line pull and speed requirements defined in the XM806E1 ATPD.

2.6 SAFETY

2.6.1 Objective

The objective was to determine the suitability of the vehicle, winch, and crane for service-testing and use with regard to personnel safety, operational hazards, and safe-guards to prevent accidents during use of the vehicle and to effect a safety release statement early in the test.

2.6.2 Criteria

Test Directive, Appendix VI.

2.6.3 Method (MTP 2-2-508)

Safety evaluation tests were conducted, on an expedited basis, as soon as possible after the test item was delivered. The following tests were performed to the degree required to determine if any safety hazards existed:

a. Center of gravity (ref par. 2.12).

b. Steering (ref par. 2.13).

c. Maximum speeds (ref par. 2.14).

d. Braking (ref par. 2.16).

e. Gradeability (ref par. 2.8).

f. Side slopes (ref par. 2.9).

g. Weapon fields of fire (ref par. 2.18).

h. Limits of vision (ref par. 2.17).

i. Winch (ref par. 2.17).

j. Crane (ref par. 2.18).

2.6.4 Results

The safety release recommendation encompassed all items listed in paragraph 2.6.3. The safety statement was provided to USATECOM; a copy is included in Appendix VI.

Operational hazards exist when towing an M113A1 down slopes in excess of 30%, and it was recommended that slopes in excess of 20% be descended exercising extreme caution. Stopping distances with a towed load were twice that of the independent vehicle. It was recommended that slower speeds be maintained when conducting towing operations. The side spades in the travel position created a weapon firing and sighting restriction for approximately 10 degrees of azimuth at two locations. The gun sight line must be elevated approximately 1.5 degrees above the horizontal firing line to avoid the spades. Although a ballistic test was not made, a general evaluation indicates a potential hazard. The caliber .50 round may penetrate the aluminum spades, however, the jacket of the projectile could possibly ricochet and either enter through an open cargo hatch or strike the machine gunner.

Inappropriate weather conditions prevented any amphibious operations prior to the safety evaluation. Subsequent testing did not disclose any amphibious operational hazards.

2.6.5 Analysis

The operator's manual should warn of the towing and weapon firing hazards. **ECP - EO E1006 provides for a towing caution plate in the vehicle stating: "DANGER steering and brake response reduced when towing a disabled vehicle".**

2.7 STANDARD OBSTACLES

2.7.1 Objective

The objective was to determine the ability and specify limitations of the vehicle to negotiate the following obstacles:

a. Vertical wall.

b. Trench profile.

c. Bridging.

2.7.2 Criteria

Criteria are as follows:

a. M113A1 military specification, Reference 1, paragraph 3.6.

b. XM806E1 ATPD, Reference 2, paragraph 3.6.

2.7.3 Method (MTP 2-2-611)

The vehicle was operated with rated payload at slow speed over the obstacles outlined in paragraph 2.7.1.

2.7.4 Results

On a level surface, the center of the front towing eyes are 24 inches above ground level. If the vehicle approaches a vertical wall from a level surface, the tracks will provide sufficient traction to power the vehicle over the obstacle. However, on a slight downgrade approaching the 24-inch vertical wall, the front towing eyes will interfere sufficiently to prevent the vehicle from negotiating the obstacle.

The test vehicle was able to negotiate the trench profile without interference and successfully bridged 72 inches.

2.7.5 Analysis

Both the M113A1 specification and the XM806E1 ATPD, require negotiation of a 24-inch vertical wall and a bridging capability of 66 inches. The test vehicle met the criteria.

2.8 GRADEABILITY

2.8.1 Objective

The objective was to determine the capability of the vehicle to comply with the following combat vehicle requirements:

a. Slope, 60%. Vehicle with rated payload must be capable of ascending and descending a dry paved slope without difficulty in both forward and reverse gears.

b. The service brake shall be capable of stopping and controlling and the parking brake capable of holding the vehicle at gross weight on 60% slope.

c. A sustained speed of 15 mph must be maintained on a 10% slope.

The engine shall start and perform satisfactorily throughout the speed range of engine in each direction on the 60% slope. All components shall operate without faulty lubrication, cooling, fuel supply, leakage, or other malfunction.

The maximum slope the vehicle can safely traverse in either direction while towing a M113A1 shall also be determined.

2.8.2 Criteria

Criteria are as follows:

a. M113A1 military specification, Reference 1, pars. 3.6.6, and 3.6.7.

b. XM806E1 ATPD, Reference 2, pars. 3.6.6 and 3.6.7.

c. Comparison with the basic M113 recovery vehicle, Reference 3.

2.8.3 Method (MTP 2-2-610)

Operations were conducted on the paved slopes in the Munson test area up to and including the 60% slope. Surface conditions were dry during the test. Operations were conducted to achieve the objectives and check for conformance to the stated criteria. Service and parking brakes were used on 60% slope.

A standard M113A1 (total vehicle weight of 23,400 pounds) was towed up and down the longitudinal slopes. The 10% slope was attempted first, then slopes in increments of 10% were tested until the vehicle was unable to negotiate the slope or unsafe conditions prevailed.

2.8.4 Results

The test vehicle, combat loaded, was capable of ascending the 60% slope at a speed of 3.0 mph in first gear with the engine operating at 1940 rpm. The brakes satisfactorily held the vehicle in both ascending and descending attitudes on the longitudinal slope.

The test vehicle while towing a M113A1 (gross vehicle weight of 23,400 pounds) was capable of ascending a 30% slope; however, the brakes would not hold. The brakes satisfactorily held facing up a 20% slope. The test vehicle was capable of descending and braking on a 20% downgrade. The brakes satisfactorily held the test and tow vehicles descending the 30% slope. However, steering control became hazardous because of the weight transfer and pintle load imposed by the towed M113A1 which caused loss of effective track-to-road surface adhesion.

Traveling up a 10% slope, the test vehicle was capable of achieving only 14.8 mph road speed in second gear with an engine speed of 2000 rpm. The hydraulic pump drive belts were removed and the test was repeated. Without the hydraulic pump drive belts, the test vehicle maintained a speed of 15.2 mph in second gear with 2100 engine rpms.

The engine power loss required to drive the hydraulic pump was evaluated ascending varying grades. The roadspeeds for varying grades with and without the hydraulic pump drive belts connected are tabulated in Table 2.8-I.

Table 2.8-I. Road Speeds of the XM806E1 With and Without the Hydraulic Pump Drive Belt Connected

		Connected Hydraulic Pump Drive Belts		Disconnected Hydraulic Pump Drive Belts	
Slope, %	Gear	Road Speed, mph	Engine Speed, rpm	Road Speed, mph	Engine Speed, rpm
10	2	14.8	2000	15.2	2100
15	2	10.0	2050	10.3	2080
20	1	9.6	2600	9.8	2630
30	1	5.8	2100	6.0	2140
40	1	4.2	2000	4.6	2030

2.8.5 Analysis

In general, the XM806E1 performance on the longitudinal slopes was comparable to the M113A1. The XM806E1 climbing, stopping, holding and restarting capabilities met the requirements specified by the military specification for the M113A1, Reference 1 and the ATDP (Reference 2).

The operator's manual for the XM806E1 should include towing restrictions. A towing caution plate is to be provided under ECP - EO E1006. Ascending slopes in excess of 20% should be prohibited with a towed load because of holding limitations. Descending slopes should be limited to 20% because of hazardous steering control.

2.9 SIDE SLOPES

2.9.1 Objective

The objective was to check for lateral stability and proper engine operation and vehicle performance on side slopes up to 30% with and without a M113A1 in tow.

2.9.2 Criteria

Criteria are as follows:

a. M113A1 military specification Reference 1, paragraph 3.6.6.

b. XM806E1 ATPD, Reference 2, paragraph 3.6.6.

2.9.3 Method (MTP 2-2-610)

Operation was conducted on the 30% side slope in both directions. Under static conditions, the suspension deflections and maximum vehicle inclination of the body were noted. Behavior of the vehicle was noted at speeds up to 5 mph, particularly while steering up and down the slope both with and without an M113A1 in tow.

All components should be capable of operation without faulty lubrication, cooling, fuel supply, leakage, or other malfunction.

2.9.4 Results

The test vehicle, fully loaded, performed satisfactorily on the 30% side slope. There were no steering problems while traversing up and down the slope in a sine wave pattern up to five mph.

The vehicle body inclination was recorded for the test vehicle traversing the slope on both directions. The results appear in Table 2.9-I.

Table 2.9-I. Vehicle Body Inclination on 30% Side Slope

	Body Inclination
Right side up slope	32.1%
Left side up slope	32.1%

During operation, all components operated without lubrication, cooling, or fuel supply leakage, or other malfunctions.

Basic vehicle steering control and stability were not degraded on the 30% side slope with an M113A1 (gross vehicle weight 23,400 pounds) in tow.

2.9.5 Analysis

The test vehicle met the engine restart requirement established by both criteria.

Side-slope operation with an M113A1 in tow does not limit the capabilities of the independent vehicle.

2.10 SWIMMING

2.10.1 Objective

The objective was to determine if the swimming ability of the basic vehicle has been adversely affected by the installation of the recovery equipment.

2.10.2 Criteria

Criteria are as follows:

a. M113A1 military specification, Reference 1, paragraph 3.6.9.

b. XM806E1 ATPD, Reference 2, paragraph 3.6.9.

2.10.3 Method (MTP 2-2-501)

Preliminary operation was conducted in the fording basin, general amphibious operating characteristics were observed in Spesutie Narrows with the test vehicle combat loaded.

Freeboard, list, and trim measurements were recorded under both static and dynamic conditions. Stability was observed while static and maneuvering, and limitations on speed and steering were noted. Vehicle water speed was measured to reflect propulsive characteristics in water having minimum current velocity.

Evaluation of maneuverability consisted of determining if the vehicle holds a straight course and evaluating turning response.

2.10.4 Results

Maximum water speed was 3.2 mph, measured in the 1-2 gear range at an engine speed of 2000 rpm. Test vehicle weight was 24,500 pounds.

Table 2.10-I includes amphibious operations measurements for static and dynamic conditions.

Table 2.10-I. Amphibious Operations Measurements for the XM806E1

	Static	Dynamic
Freeboard, inches		
Right front	11	10
Left front	10	8
Right rear	15	10
Left rear	14	8
List, degrees	1 (left)	1 (left)
Trim, degrees	2 (forward)	0

Maneuverability was similar to that of the basic M113A1. There were no steering problems and the test vehicle was able to hold a reasonably straight course. Photographs of the test vehicle in the amphibious mode appear in Appendix II.

The XM806E1 did not require any additional time for amphibious operation preparations beyond that needed for the M113A1.

There was no appreciable water accumulation in the hull during amphibious operations.

The bilge-pump rear outlet points directly at the right side spade. If an adequate amount of water is removed by the bilge, the water would jettison against the spade and splash back into the cargo area through an open hatch (EPR K2-20).

2.10.5 Analysis

The criteria for the M113A1 and the XM806E1 both require a maximum speed of not less than three mph. The test vehicle successfully met the criteria.

A deflector for the rear bilge outlet is to be provided for by ECP - EO D9969.

2.11 LOAD DISTRIBUTION AND GROUND PRESSURE

2.11.1 Objective

The objective of this test was to determine the vehicle gross weight and weight distribution with payload and provide a loading that will properly simulate the normal combat loading of the vehicle.

2.11.2 Criteria

Comparison with the basic M113A1 vehicle (Reference 4).

2.11.3 Method (MTP 2-2-801)

2.11.3.1 Weight. The vehicle was weighed on a platform scale with designated combat payload including OVE, full fuel tank, personnel, and weapons. This weight was compared with the gross weight of the standard M113A1 vehicle.

2.11.3.2 Weight Distribution. The weight distribution was checked in the condition noted in paragraph 2.11.3.1 by sequential weighings across a platform scale.

2.11.3.3 Ground Pressure. The ground pressure was computed for the described conditions using total vehicle weight and projected area of the track from the centerline of the first road wheel to the centerline of the fifth road wheel.

2.11.4 Results

2.11.4.1 Weight. The weight of the vehicle as determined by paragraph 2.11.3.1 was 24,500 pounds.

2.11.4.2 Weight Distribution. Static load distribution for the test vehicle weighing 24,500 pounds is shown in Table 2.11-I. A graphic comparison of static load distribution between the test vehicle and a standard M113A1 vehicle is included in Appendix I.

Table 2.11-I. Weight Distribution of XM806E1 with Driver, Simulated Crew Members, OVE, and Fully Serviced

Road Wheel	Weight, lb Left	Weight, lb Right
1	2200	2000
2	2600	2600
3	2650	2800
4	2500	2600
5	2250	2300
Total	12200	12300

2.11.4.3 Ground Pressure. The average ground pressure as determined by paragraph 2.11.3.3 was found to be 7.8 psi.

2.11.5 Analysis

The graphic comparison between the test vehicle and the standard M113A1 shows that except for the No. 4 road wheel there is no appreciable increase in road wheel loading. The XM806E1 No. 4 road wheels had an approximate 16% increased load from the weight of the recovery components.

The test vehicle was approximately 1,000 pounds heavier than a standard M113A1. The average ground pressure was therefore higher on the test vehicle, 7.8 psi as compared to 7.5 psi for the standard M113A1 vehicle. The increased weight should be beneficial for recovery operations.

2.12 CENTER OF GRAVITY

2.12.1 Objective

The objective was to determine the center of gravity of the vehicle in three planes for a loaded condition. The vehicle is fitted with OVE and full fuel tanks.

2.12.2 Criteria

Comparison with the basic M113A1, APC vehicle (Reference 4).

2.12.3 Method (MTP-2-800)

The location of the center of gravity on the lateral axis was determined by using load-reaction data (ref par. 2.11). The location of the center of gravity along the vertical and longitudinal axes was obtained by the suspension method.

2.12.4 Results

The center of gravity measurements listed in Table 2.12-I were made with the vehicle combat loaded, OVE installed, simulated crew and full fuel tank.

Table 2.12-I. Center of Gravity Location

Location	Measurement, in.
Vertically above drive sprocket centerline	17
Vertically above ground level	40
Longitudinally rearward from drive sprocket centerline	80-1/2
Laterally right of vehicle centerline	1/4

A graphic illustration of the center of gravity locations appears in Appendix I.

2.12.5 Analysis

Table 2.12-II includes a comparison of the center of gravity between a standard M113A1 vehicle and the test vehicle.

Table 2.12-II. Center of Gravity of M113A1 and XM806E1

Location	Center of Gravity, in. M113A1	XM806E1
Vertically above ground level	35-1/4	40
Longitudinally rearward from drive sprocket centerline	80-7/8	80-1/2

Vehicle weight for the standard M113A1 was 23,425 pounds and the test vehicle weight was 24,500 pounds.

2.13 STEERING

2.13.1 Objective

The objective was to determine vehicle steer response and effort, minimum turning radius, and general characteristics of turning of the test vehicle and of the test vehicle towing a standard M113A1.

2.13.2 Criteria

Criteria are as follows:

a. M113A1 military specification, Reference 1, paragraph 3.6.8.

b. XM806E1 ATPD, Reference 2, paragraph 3.6.8.

c. Comparison with M113A1 vehicle (Reference 4).

2.13.3 Method (MTP 2-2-609)

The minimum turning circle was measured with differential steering on a level, dry, paved surface of the test vehicle and with the test vehicle towing an unloaded and loaded M113A1 (gross vehicle weight 23,400 pounds).

2.13.4 Results

Using the differential steer laterals, a turning circle diameter of 46-1/2 feet was measured to the right and left without a towed load. Towing an unloaded M113A1 the turning circle diameter was 53-1/2 feet to the right and left. With a loaded M113A1 in tow, the turning circle diameter for the test vehicle was 56-1/2 feet to the right and left. The test vehicle turning diameter with a towed load was limited because of interference between the towbar and the rear fenders of the test vehicle.

The larger tow pintle (M548 type) that was provided for durability testing allowed the test vehicle to steer inside of a 50.0-foot diameter when towing a loaded M113A1. Again, turning diameter was limited because of interference between the towbar and the rear fenders.

2.13.5 Analysis

The test vehicle met the 50-foot diameter turning circle requirement established by the military specification for the basic M113A1 (Reference 1) and the XM806E1 ATPD (Reference 2). The 46-1/2-foot diameter turning circle for the test vehicle was comparable to the 44-1/2 foot diameter turning circle for the basic M113A1 (Reference 4). The turning characteristics were not degraded appreciably while towing an M113A1 vehicle. With the standard M113A1 tow pintle, the test vehicle failed to meet the XM806E1 ATPD requiring a maximum turning diameter of 53 feet while towing a free wheeling disabled vehicle. However, with the larger pintle (ECP - EO D9969), the test vehicle successfully met the ATPD criteria.

A smaller turning diameter was measured for the larger tow pintle because the larger pintle extends further to the rear of the vehicle. The additional length allows the tow bar to obtain a larger angle with respect to the centerline of the vehicle before interference occurs with the rear fenders.

2.14 MAXIMUM AND MINIMUM SPEEDS

2.14.1 Objectives

The objectives of this test were:

a. To determine the maximum road speed obtainable on level, paved surface without exceeding the maximum rated engine speed.

b. To determine minimum sustained speed in the lowest forward gear range without rough or irregular operation.

c. To determine the maximum speed permissible while towing a basic M113A1 vehicle.

2.14.2 Criteria

Criteria are as follows:

a. M113A1 military specification, Reference 1, paragraph 3.6.4.

b. XM806E1 ATPD, Reference 2, paragraph 3.6.4.

c. Comparison with basic M113A1 vehicle (Reference 4).

2.14.3 Method (MTP 2-2-602)

All operations were conducted over a level, paved highway. Maximum and minimum sustained speeds were measured with rated payload.

Towing tests were conducted with a standard M113A1 weighing 23,400 pounds.

2.14.4 Results

The test vehicle attained a maximum road speed of 41 mph at 2810 rpm in third gear. Towing an M113A1, the maximum speed obtained was 23 mph at 2900 rpm in second gear.

The minimum sustained speed without rough or irregular operation was 0.9 mph at 600 rpm in first gear.

2.14.5 Analysis

The test vehicle met the criteria of the military specification (Reference 1) and of the XM806E1 ATPD (Reference 2), requiring that the vehicle maintain a sustained speed of 30 mph and reach maximum speed of 40 mph.

The maximum speed obtained with a standard M113A1 is 42 mph. The lower maximum speed can be attributed to the increased weight of the test vehicle and the power loss driving the hydraulic pump, as indicated in paragraph 2.8.

2.15 ACCELERATION

2.15.1 Objective

The objective was to determine acceleration characteristics. Also, to assure that sufficient power and gear ratios are provided and that gear changes can be accomplished easily and quickly to accelerate the vehicle to top road speed in the shortest time and allow ready acceleration from minimum to maximum sustained speed in the highest gear range.

2.15.2 Criteria

Criteria are as follows:

a. M113A1 military specification Reference 1, par. 3.6.5.

b. XM806E1 ATPD, Reference 2, par. 3.6.5.

c. Comparison with the basic M113A1 (Reference 4).

2.15.3 Method (MTP 2-2-602)

Tests were conducted on a level, paved road. Data and curves show the engine and vehicle speeds, time, and gear combinations. Delays due to initial or subsequent shifting and unusual shock conditions imposed on the power train were noted. Tests were conducted with full payload.

2.15.4 Results

Time trials were made to obtain sufficient data to construct an acceleration curve. Average times to accelerate from zero to various road speeds are shown in Table 2.15-I.

Table 2.15-I. Acceleration Data of XM806E1

Road Speed, mph	Time, sec	Distance, ft
5	1.5	5
10	3.3	21
15	5.4	61
20	9.3	160
25	16.5	400
30	28.0	860
35	44.0	1630

The acceleration characteristics were plotted and appear in Appendix I.

2.15.5 Analysis

The military specification for the basic M113A1 (Reference 1) and the XM806E1 ATPD (Reference 2) states, "... the vehicle shall accelerate from 0 to 20 mph in not more than 11 seconds on smooth, level, hard-surfaced road." The acceleration for the test vehicle of 20 mph in 9.3 seconds met the criteria.

The acceleration of the basic M113A1 vehicle (Reference 4) was 20 mph in 8.2 seconds.

Although the test vehicle met the acceleration criteria of the military sepcification, the slower time compared to the standard APC can again be attributed to the increased weight and the power loss required to drive the hydraulic pump (paragraph 2.8).

2.16 BRAKING

2.16.1 Objective

The objectives of this test were:

a. To determine the ability of the vehicle to make a complete, safe, stable stop on a level, paved road from a speed of 30 mph.

b. To determine if the brakes will safely hold the vehicle (parked) in both directions an a 60% longitudinal slope.

c. To determine the maximum safe speed from which the vehicle can make an acceptable stop while towing an M113A1.

d. To determine the maximum longitudinal slope that the brakes will safely hold the test vehicle (parked) in both directions with a loaded M113A1 in tow.

2.16.2 Criteria

Criteria are as follows:

a. M113A1 military specification Reference 1, par. 3.6.7.

b. XM806E1 ATPD, Reference 2, par. 3.6.7.

c. Comparison with M113A1 vehicle, Reference 3.

2.16.3 Method (MTP 2-2-608)

Stopping distances from 10, 20, and 30 mph on a dry, bituminous concrete roadway, from point of application until the vehicle has been halted with the maximum braking effort, were measured with and without a towed load. The holding ability on the 60% slope was determined during gradeability tests. With a towed load, the holding ability was first attempted on a 10% slope and slopes in increments of 10% were tested until the holding ability was unsatisfactory or until unsafe conditions prevailed.

2.16.4 Results

The stopping distance for the test vehicle, weighing 24,500 pounds on a dry, paved surface are listed in Table 2.16-I. Also included in Table 2.16-I are stopping distances of the test vehicle towing a loaded M113A1, weighing 23,400 pounds, for the same road conditions.

Table 2.16-I. Stopping Distances for the XM806E1 With and Without Towed Load

Road Speed, mph	Average Stopping Distance, ft	
	Without Towed Load	With Towed Load
10	7	14
20	27	60
30	77	-

With an M113A1 in tow, uneven pulls on the steering laterals caused severe swerving of the test vehicle during panic stops from the faster road speeds because the towed weight amplified the uneven brake applications. However, after a few trials the operator was able to reduce swerving considerably.

The brakes were able to hold the XM806E1 in either attitude on the 60% slope. With an M113A1 in tow, the brakes of the test vehicle satisfactorily held facing up a 20% slope but would not hold on the 30% slope. Descending a 30% slope, the brakes satisfactorily held but steering control became hazardous and slopes in excess of 30% were not attempted.

2.16.5 Analysis

The brakes of the test vehicle satisfactorily met the criteria of the M113A1 and of the XM806E1 ATPD since they held the vehicle in either attitude on the 60% slope and stopped within the 40-foot requirement from a road speed of 20 mph.

Since the stopping distance with a towed load was at least twice that of the independent vehicle, towing operations should be conducted at a slower speed. The operator should be cautioned about the hazards associated during towing operations in the operator's manual.

The operator should be advised of the towing hazards when negotiating longitudinal slopes. The warning note should be evident in the operator's manual. An instructional plate fastened inside the vehicle warning the operator is to be provided by ECP - EO E1006.

2.17 WINCH KIT

2.17.1 Objectives

The objectives were:

a. To obtain physical and operating characteristics of the winch.

b. To determine the suitability of the winch to aid in self-recovery of the vehicle or recovery of other vehicles of similar weight immobilized in adverse terrain.

To determine any adverse effects the recovery equipment may have on the operation of the basic M113A1 vehicle.

2.17.2 Criteria

Criteria are as follows:

a. XM806E1 ATPD, Referecne 2. par. 3.6.13.

b. Comparison with M113 recovery vehicle, Reference 3.

2.17.3 Method (MTP 2-2-712)

2.17.3.1 Limits of Vision. Visual restrictions experienced by the winch operator were noted on polar coordinate paper.

2.17.3.2 Functional Test. The ability of the winch to recover a fully loaded M113A1 in various terrain environments was evaluated by recording line pulls. Recovery operations were conducted on the 10, 30, 40, and 60% longitudinal slopes, in sand and clay courses, and in the Munson swamp area. In the swamp area, tests were run for direct-pull, maximum angle of pull, and one position midway between these extremes. The ability of the vehicle to winch and tow simultaneously was evaluated. The suitability of guards and safety devices used with the winch was determined. The ability of the vehicle to winch itself up a 60% slope was tested. The spade emplacement and retraction times were checked with and without the center section. The effectiveness of the center spade section was evaluated for a soft soil condition by measuring the maximum line pull attainable with only the side spades and for the same soil conditions the line pull attainable with the center spade section installed. The effectiveness of level wind cable feeding was evaluated during side-slope winching operations starting with a 10% side slope and paying in the cable with no-load. Side slopes were then tested in 10% increments until unsatisfactory spooling occurred. Vehicle stability was evaluated on side slopes up to 30% during winching operations.

2.17.3.3 No-Load Line Speed. The no-load line speed was determined at each spooling layer. The total times for pay-in were recorded. Three runs were made at each condition.

2.17.3.4 Winch Capacity. The maximum line pull the winch can develop was determined for each spooling layer. This was accomplished by gradually increasing the load on the line until the relief valve actuated. The line speed and relief pressure at maximum load were recorded for each condition. Three runs were made at each condition.

2.17.3.5 Winch Brake Capacity. The maximum line pull the brake can hold at each spooling layer was determined by pulling against the brake until the hydraulic motor was driven in reverse, the relief valve actuated, or the brake clutches slipped. Line pulls in excess of the winch capacity (ref par. 2.17.3.4) were not tested. Three trials were made at each condition. The brake release was also checked to determine possible drag or chatter characteristics.

2.17.3.6 Fleet Angle. The maximum horizontal fleet angles from the vehicle centerline that the winch may be operated was determined. This determination was made at full-load, empty spool.

2.17.3.7 Oil Temperature. The maximum operating time possible while the hydraulic reservoir temperature went from ambient temperature to +160°F was determined using the following sequence:

a. Starting at full drum, all the cable was payed-out without load.

b. 15 seconds pause.

c. All the cable was payed-in at specified load.

d. 15 seconds pause.

e. The cycle was repeated until the hydraulic temperature reached +160°F.

Curves of time versus temperature were plotted using ambient temperatures of +120°F, +100°F, +85°F, and +30°F for 90% and 50% of the maximum rated load determined in paragraph 2.17.3.4 for each spooling layer.

No auxiliary cooling device was used during this phase. Winching time was counted toward total endurance time. The time required for the reservoir to cool down to ambient temperature from +160°F was also recorded for the trials with and without the engine running.

2.17.4 Results

2.17.4.1 Limits of Vision. A polar plot of the operator's limits of vision is included in Appendix I. To execute a line pull to the right of the vehicle with the ramp closed, the operator had to stand up to view the operation through the cargo access door.

When the spades were in the travel position, they created a firing and sighting restriction for the cupola gun for approximately 10° of azimuth at two locations over the rear of the vehicle. To avoid the spades, the gun sight had to be elevated approximately 1.5° above the horizontal line of sight (EPR K2-38).

2.17.4.2 Functional Test. An M113A1 with gross vehicle weight of 23,400 pounds was used for retrieval operations. Table 2.17-I summarizes the recovery operations conducted. The final drives were disconnected on the disabled vehicle, hence the line pull represents the force required to retrieve a free rolling vehicle. Varying cable lengths were used during this phase as indicated by pay-in time.

Table 2.17-1. Recovery Operations for the XM806E1 and A Disabled M113A1

Terrain Condition	Amb Temp, °F	Hydraulic Oil Temp, °F Start	Hydraulic Oil Temp, °F Finish	Elapsed Time Pay-In, Min	Average Line Pull, lb
Slope, paved longitudinal, %					
10	+55	+60	+73	5.2	3000 to 3200
	+55	+78	+88	4.4	3000 to 3200
30	+55	+86	+90	2.1	6900 to 7400
	+55	+94	+97	1.9	6900 to 7400
40	+55	+84	+88	1.7	9000 to 9500
	+55	+90	+92	1.4	9000 to 9500
60	+55	+89	+91	1.2	12400 to 12900
	+55	+94	+96	1.3	12400 to 12900
Sand, 7% moisture cone index:					
25 at 3 in.	+67	+73	+88	5.7	1900 to 2100
35 at 6 in.	+67	+84	+98	5.3	1700 to 2100
55 at 12 in.	+67	+85	+90	1.8	1800 to 1900
Clay, cone index:					
50 at 3 in.					
100 at 6 in.					
200 at 12 in.	+65	+95	+107	5.6	2800 to 3600
Sandy loam, 19% moisture, cone index: less than 5 at depths up to 18 in.	+64	+93	+104	5.7	5600 to 8500
Munson swamp	+65	+76	+82	3.3	4400 to 9400
	+65	+87	+92	1.6	13500 to 16000
	+68	+92	+97	1.5	9000 to 20000
	+68	+88	+90	2.1	-
	+68	+90	+95	1.7	-
	+68	+90	+105	5.5	-

The different line pulls recorded for the Munson swamp area is attributable to varying amounts of vegetation build-up and irregular terrain. The maximum fleet angular pulls during swamp recovery operations did not display any unstable condition. Two recovery operations in the swamp area were conducted utilizing the cable bridle as the anchor for a double line pull. One swamp recovery operation was conducted with the cable bridle attached to the rear lifting eyes of the disabled vehicle. Vegetation and mud build-up was quite significant as the disabled vehicle plowed through the swamp. All other recovery operations employed the rear towing eyes with the cable bridle.

The XM806E1 simultaneously winched and towed an immobilized M113A1 from the Munson swamp area. Caution had to be exercised since the engine throttle control regulated vehicle and winch drum speed jointly.

The test vehicle twice winched itself up a dry, paved, 60% slope. A double-line pull was employed utilizing the cable bridle attached to the rear towing eyes.

The guards and safety shields provided sufficient operational protection. One shortcoming was reported for the shields. The right hinge pin for the right rear personnel safety shield worked free twice during the course of the test (EPR's K-2, 30 and 55(30-2)). The pin apparently worked free from vehicle vibration and frequent slamming of the gate against the ramp when the winch operator left the personnel compartment.

The effectiveness of the center spade section was evaluated in loose sand (cone index: 20 at 3 in., 30 at 6 in., 50 at 12 in., and 150 at 18 in.) Using the cable bridle provided as OVE, a double-line pull was attempted. A load of 17,500 pounds was recorded on one line before the two side spades began plowing sand. The vehicle was relocated in the sand and the center section was installed. As a load of 20,000 pounds was recorded on one line, the spades again began to plow the soil. Sand began to spill over the top of the center section at the 20,000-pound load condition and the center section did not contribute additional resistance. In a firm soil environment of packed sandy loam (cone index: 300 at 6 in.) and with the side spades embeded, a double-line pull was applied along the winch centerline using the cable bridle. At a total load of 42,000 pounds the vehicle began to pivot about the spades and the road wheels were lifted off the ground.

The spade emplacement and retraction times were evaluated with and without the center section. Table 2.17-II includes the results of the time study for normal and hastened conditions. The times listed are the result of three trials.

Table 2.17-II. Spade Emplacement and Retraction Times

Emplacement Condition	Time, min. Minimum	Normal
Emplacement of both side spades (driver, two crewmen)	0.3 to 0.4	1
Retraction of both side spades (driver, two crewmen)	0.3 to 0.5	1 to 2
Emplacement of both side spades with center blade from travel position (driver, two crewmen)	2.2 to 3.6	4 to 5
Retraction of both side spades with center spade to travel position (driver, two crewmen)	1.7 to 2.0	5 to 6

Side-slope winching operations indicated that the levelwind was marginally satisfactory on the 20% slope. Using only the fair-leader cable tensioner to provide cable load, spooling was satisfactory along both directions of the winch drum with the right side of the vehicle facing up the slope. With the left side of the vehicle facing up the slope, spooling was satisfactory to the left but cable separation became evident between wraps when spooling to the right. Separation was particularly evident in the crossover areas.

The vehicle was stable on the 20 and 30% paved side slopes without any tipping hazard. The spades were in the travel position with the vehicle brakes applied. The line pull was made at the maximum fleet angle down the slope. A line pull of 8920 pounds was recorded on the 20% side slope before the vehicle began to slide toward the applied load. A 6560-pound load was recorded on the 30% side slope before vehicle sliding was started.

2.17.4.3 No-Load Line Speed. The line speed in low gear for a 19,000 pound load on bare drum was measured at 6 feet per minute (fpm) (EPR K2-10-(-4-2)). The 6 fpm was significantly lower than the manufacturer's data of 20 fpm at maximum load. The original no-load engine speed was 1800 rpm as indicated by the manufacturer's manual. The no-load engine speed was gradually increased until an acceptable full-load line speed was achieved. A no-load engine speed of 2700 rpm provided a 19.4 fpm line speed at full load of 20,000 pounds. Since this was approaching maximum engine speed, 2700 rpm was established as the no-load engine setting for winch performance characteristics.

The maximum no-load line speed in both high and low gears was included in Tale 2.17-III. The listed data were the average of three trials.

Table 2.17-III. No-Load Line Speed

Spooling Layer	Speed, fpm Low Gear	High Gear
1 (bare drum)	39	162
2	42	177
3	46	194
4	50	211
5	53	231

No-load engine idle speed was 2750 rpm.

The effect of engine speed on hydraulic-temperature increase and cable-line speed was investigated. The cable load was maintained at 10,000 pounds and low gear was used for all winching operations. Table 2.17-IV lists hydraulic oil-temperature increase and cable-line speed for various engine speeds. Spooling layer number one is defined as the bare-drum layer.

Table 2.17-IV. Engine Speed vs Cable Line Speed and Hydraulic Oil Temperature for 10,000-Pound Load in Low Gear

Engine Speed, rpm		Line Speed, fpm					Hydraulic Oil Temp Increase, °F
		Spooling Layer					
No Load	Full Load	1	2	3	4	5	
2750	2450	26.2	35.3	37.3	38.7	39.4	+6
2500	2000	20.7	23.3	25.4	27.6	28.7	+7
2300	1800	17.5	21.7	22.1	22.3	22.8	+5
2100	1700	16.6	19.3	20.2	20.8	21.1	+5
1800	1130	14.1	-	-	-	-	-

2.17.4.4 Winch Capacity. The maximum line pull that the winch developed as tabulated in Table 2.17-V. The data listed were the averages of three trials at each spooling layer. All loads were applied as a single line pull along the winch centerline.

Table 2.17-V. Maximum Winch Single-Line Pull

Spooling Layer	Line Pull, lb Low Gear	High Gear
1 (bare drum)	20500	4950
2	19400	4250
3	17750	4000
4	16000	3500
5	14800	3150

The relief valve limited the maximum line pull. The pressure setting at maximum load varied between 1500 to 1550 psi.

2.17.4.5 Winch Brake Capacity. The winch brake was capable of holding the maximum line pulls recorded in paragraph 2.17.4.4. There was not any apparent drag or chatter.

2.17.4.6 Fleet Angle. The maximum vertical depression and horizontal angles from the winch centerline at which the winch could operate at full load with an empty spool are listed in Table 2.17-VI. The side spades were embedded to represent typical operating conditions.

Table 2.17-VI. Maximum Winch Oeerational Angles for Test Vehicle

Condition	Angles, deg Left of Winch Centerline	Right of Winch Centerline	Depression Below Winch Centerline
Ramp open, safety shroud in position	46	51	34
Ramp closed, access door open	47	10.5	23.5

The left side spade was the restriction for a left side line pull in both modes. The ramp was the limiting obstacle when the line pull was attempted to the right with the access door open. A line pull to the right with the ramp down revealed that the right side spade was the limiting factor. The access door opening and the edge of the ramp were the limiting factors for a line pull below the winch centerline with the ramp closed and open respectively.

A 20,000-pound line pull at the maximum fleet angles did not cause any unstable vehicle condition.

2.17.4.7 Oil Temperature. The results of cable pay-out at no load and pay-in at 50 and 100% of the maximum loads shown in Table 2.17-V for four different ambient temperature environments are included in Table 2.17-VII. Except for two wraps on the bare drum, the full length of cable was paid out. Operations were halted when the hydraulic oil temperature in the reservoir reached +160°F.

Table 2.17-VII. Operational Characteristics for XM806E1 Hydraulic Oil in Various Temperature Environments

Temperature, °F Amb	Hydraulic Oil at Start	% of Maximum Load	Minutes of Operation	Number of Cycles Completed
+ 30	+ 58	100	50	3
+ 30	+100	50	40	3
+ 85	+ 96	100	25	1
+100	+103	100	22	1
+100	+113	50	28	2
+120	+127	100	11	0
+120	+125	50	14	0

A complete cycle was defined as full cable-length pay-out and in.

The higher temperature of the hydraulic oil than the surrounding ambient was caused from the engine idling to reach operating temperature. The results in Table 2.17-VII appear graphically in Appendix I.

The average rate of hydraulic-oil cool-down from +160°F for one hour was 0.25 deg per min with the engine off and 0.64 deg per min with the engine idling. Complete cool-down characteristics appear graphically in Appendix I.

2.17.5 Analysis

The winch location in the XM806E1 was similar to the location in the M113 vehicle. However, the hydraulic system characteristics were slightly altered. No load engine idle condition for winching with M113 vehicle was approximately 3000 rpm as compared to 2700 rpm for the XM806E1.

The hydraulic relief valve setting was also changed from 2000 psi on the M113 to 1550 psi on the XM806E1. The subsequent change in the engine speed and relief valve setting changed the line speed and maximum line pull characteristics. Table 2.17-VIII indicates the differences between the M113A1 vehicle and the XM806E1 line speed and maximum pull characteristics.

Table 2.17-VIII. Line Speed and Maximum Pull Characteristics of the M113 Recovery Vehicle and the XM806E1

Characteristic	XM806E1	M113 Recovery Vehicle
Maximum single line pull, pounds		
Low gear, empty drum	20900	26275
Low gear, full drum	14800	19170
High gear, empty drum	4950	6000
High gear, full drum	3150	4200
Line speed, maximum, no load, fpm		
Low gear, empty drum	39	39.0
Low gear, full drum	53	55.2
High gear, empty drum	162	155.4
High gear, full drum	231	218.4

The test vehicle was versatile during recovery operations. The cable bridle for a double-line-pull capability and satisfactory vehicle stabilization during maximum fleet-angle line pulls enhanced recovery operations. Typical recovery operations of a disabled M113A1 vehicle in varying terrains indicated that 50% of the maximum spooling-layer line pulls was representative of expected cable loading. Controlled environmental tests at +120°F indicated that one full cable length recovery operation at 50% load could not be conducted before hydraulic fluid temperature required a halt in operations. Approximately 40 minutes with the engine idling and circulating hydraulic fluid were required before another recovery operation could be attempted. However, in a controlled environment of +100°F, two full length cable recovery operations could be completed at 50% rated spooling layer load.

Vehicle manuals indicating a 1800-rpm no-load engine speed should be changed to reflect the required engine speed of 2700 rpm necessary to achieve the desired full load line speed. Lowering the engine speed to 2500 rpm had an appreciable affect in lowering line speed. However, the line-speed decrease for engine speeds below 2500 rpm did not have the same appreciable change. For the same load conditions, the line speed did not significantly affect hydraulic-fluid temperature increase. Hence, hydraulic-fluid temperature increase was more affected by line pull than by line speed.

Appropriate warning should be included in the operator's manual warning of the field of fire restriction imposed by the side spades in the travel position.

The center spade section was capable of providing an additional 5000 pounds of towing resistance for a double-line pull beyond the capabilities of the two side spades alone.

The rear anchors were reported unsatisfactory during the M113 recovery vehicle test. A double line pull using one anchor, tended to pivot the vehicle about the side spade on the opposite side of the anchor under load. The XM806E1 is equipped with an additional bridle for double line pulls. The bridle mounted on the two vehicle anchors and provided an eye for the cable chain hook during double line pulls which is along the vehicle centerline. The movement produced during the M113 vehicle test is eliminated and the cable pull resistance is appreciably increased.

The safety-gate hinge-roll pin is to be replaced by a bolt as indicated by ECP - EO D9968.

The XM806E1 ATPD requires that operating in an ambient air environment of +115°F, and with an initial hydraulic oil temperature of +125°F, the hydraulic oil shall remain below +170°F for 300 feet of cable pay-in at full load. Since the ATPD was not received until late in the test, this requirement was not specifically tested. However, extrapolating data obtained from the environmental tests at +120°F and paying-out the full length of cable prior to pay-in, the hydraulic system should meet this requirement. The ATPD also requires that the pressure-relief valve be adjusted to provide a pressure of 1625 ± 25 psi. The test vehicle operating relief pressure was 1550 ± 50 psi. The pressure setting could have been adjusted to meet the requirement. All other ATPD requirements, for the winch and associated components, were met.

2.18 CRANE

2.18.1 Objectives

The objectives were:

a. To obtain physical and operating characteristics of the crane.

b. To determine limitations and safety factors involved in using the crane.

2.18.2 Criteria

Criteria are as follows:

a. XM806E1 ATPD, Reference 2.

b. Comparison with M113 recovery vehicle, Reference 3.

2.18.3 Method (MTP 2-2-707)

Weapon and visual interference points caused by the crane in its various positions were plotted on polar coordinate paper. Measurements of angular displacements and crane reach from the side of the vehicle at different angles were recorded.

The functional suitability of the crane was tested by removing and replacing a M113A1 power pack. The power pack was lifted enough to clear the M113A1 and held for ten minutes before replacement was initiated. Observations were made of crane utility and safety.

The force required on the pump handle at the rated capacity was measured.

The average lifting rate was determined by obtaining the time required for the crane to move through its limits of travel. The average distance the crane moved per pump-handle stroke was determined. Readings were taken, as a minimum, at maximum and no-load conditions. Three readings were taken, using different personnel for each run.

The leakage rate at maximum rated load was determined by raising the weight to the horizontal boom position and holding for at least 15 minutes. The distance the weight dropped during this period was recorded.

2.18.4 Results

The crane on the XM806E1 is similarly located on the hull as the M113 recovery vehicle. The angular displacements weapon and visual interference and crane reach from the side of the vehicle were not measured since any data collected on the XM806E1 would be duplication of the M113 recovery vehicle data. The data is included in Appendix I.

With a 4000 pound load, the boom could not be traveled through its vertical limits by one man without a rest period. The effort required varied from 40 pounds near the lower limit to 80 pounds as the upper limit was approached. Corresponding values of vertical motion per stroke ranged from 0.27 to 0.49 inch. The average distance one man could raise the 4000 pound weight was 22 inches.

The number of strokes required to move the boom without load through its limits of travel ranged from 201 to 219 for three different men. Corresponding lifting times varied from 2.6 to 3.5 minutes. Vertical movement between the travel limits was 73 inches with the retracted boom.

The crane was capable of holding for one hour, without drift, a 4000 pound load.

Safety factors to be considered when using the crane are listed in the safety recommendation included in Appendix VI.

The test vehicle satisfactorily removed and replaced an M113A1 power pack.

2.18.5 Analysis

The crane was structurally strong enough to hold the design rated loads. Operation was satisfactory for power-pack removal and replacement because the crane was operated intermittently as the power pack was eased out of the engine compartment. However, the driver effort for continuous operations with the rated load was excessive. The crane was unsatisfactory for repetitive operations with a heavy load but it was suitable for repetitive operations with a light load or a single operation with a heavy load.

The crane on the XM806E1 was identical to the crane on the previously tested M113 recovery vehicle.

2.19 DURABILITY

2.19.1 Objective

The objective was to determine the durability characteristics and reliability of the vehicle and recovery kit over 4000 miles of operation on prescribed test courses, 100 hours of winch operation and 12 hours of crane operation.

2.19.2 Criteria

Not applicable.

2.19.3 Method (MTP 2-2-507)

The scheduled endurance operation with a minimum objective of 4000 miles of operation and 100 hours of winch operation was divided into alternate cycles of 1000 miles and 25 hours, respectively. A typical vehicle operation cycle is shown in Table 2.19-I.

Table 2.19-I. Endurance Cycle, Vehicle Operation

Course	Miles	Condition
Perryman	266	Level cross-country
Churchville	266	Hilly cross-country
Primary road	234	Paved
Secondary road	234	Gravel

One vehicle operation cycle was conducted with a fully loaded M113A1 in tow. The safety requirements established during the performance testing were strictly followed.

The vehicle endurance cycle was followed by a winch endurance cycle which was conducted in the following sequence:

a. The line was reeled in until the first (empty drum) layer was full, and then payed out using 25% maximum rated load in both cases.

b. The first drum layer was then payed in and out using 50%, 75%, and finally 100% maximum rated load in the same manner as in a.

c. The same process described in a and b was repeated for the second drum layer only. When this was accomplished, similar runs were made for the third, fourth, and fifth layers.

d. The entire sequence was repeated until 25 hours of endurance time were accumulated.

e. The winch was allowed to cool for one hour after two hours of winching.

Actual winching time only was counted toward endurance operation. At no time during operations was the winch run with hydraulic reservoir temperatures in excess of 160 to 165°F. An auxiliary cooling device was used. The maximum and percentages of the rated loads were defined according to the characteristics obtained in paragraph 2.17.

After the test vehicle accumulated the prescribed 4000 vehicle miles, 100 winching hours, and 12 crane hours, a final inspection was conducted (par. 2.22). The vehicle was operated for an additional 1000 miles, as required in Table 2.19-I, with an M113A1 in tow to evaluate the durability of a stronger tow pintle (M548 type). Since the vehicle was not rebuilt after the prescribed 4000-mile test, all defects that occurred during the 1000-mile towing test were reported for information only.

Prior to the additional 1000 miles of towing, lock washers were installed on all the sprocket-to-carrier and carrier-to-hub bolts on the left side per TECOM letter, 7 April 1969 (Appendix VII). Periodic torque readings were taken on both sides.

2.19.4 Results

During the prescribed test phase, the XM806E1 was operated for 4035 vehicle miles, 102 winch hours, and 12 crane hours. Table 2.19-II lists the mileage accumulation on the various test courses.

Table 2.19-II. Vehicle Endurance Operation Completed

Course	Service Miles	
	Without Towed Load	With Towed Load
Perryman, level cross-country	794	274
Churchville, hilly cross-country	812	269
Paved, primary road	708	234
Gravel, secondary road	707	237
Totals	3021	1014

During the 102 winching hours, the most serious failure occurred after 59.8 hours. One spur gear on the stage three carrier assembly was found to be broken into three pieces (EPR K2-45). Several cracks were found propagating 1-1/4 inches along the length of the failed gear. Cracks were found on the two other gears from the same carrier in the area of the gear-tooth roots. A metallurgical investigation revealed that there was no definite fracture pattern that indicated the origin of failure. The fracture mode appeared to be brittle. A chemical evaluation showed that the steel was within specifications and a hardness study indicated that the case hardness was also within specification. However, the following defects were detected: weak grain boundaries in the case; carbides at or near the surface of the case; high concentration of stringer-type inclusions stretched in the longitudinal plane (same direction as the fracture); and longitudinal series of oxide-type inclusions. The concentration of carbides in the case was the most likely cause of the fracture. Other factors, such as heavy stringer-type inclusions, may have contributed to the failure.

A new winch assembly was used to replace the failed components. The second stage sun gear contained heavy grinding check patterns on the end face adjacent to the planetary gears (EPR K2-57).

One other mechanical winch drive failure was recorded during the durability phase. After 51.8 winch hours, the operator could not completely engage the winch-control handle in either high or low gear. The motor-coupling splines which engage with the shift-rod coupling spool were damaged (EPR K2-35). Metal was found milled from the edges of the splines. Apparently, the shift-rod spool became slightly misaligned and milled the splines of the motor coupler. As a result of the misalignment, slight wear was evident on the edges of the spool splines that engage with the planetary gears (EPR K2-36). The rough-splined surfaces were sanded and the leading edges rounded to improve engagement, and the winch was reassembled to the motor. There were no recurring defects for the remainder of the test.

Only one defect was detected for the hydraulic-fluid system. Fluid streamed from the counterbalance valve after 5.4 winch hours (EPR K2-11). Disassembly of the lower head from the valve body revealed a quality-assurance defect. The gasket was deformed and the valve-body interface was gouged.

During winching operations, the operator noticed that the winch speed was gradually decreasing and finally stopped. Investigation revealed that the two hydraulic pump drive belts (EPR K2-13) and an engine cooling fan drive belt (EPR K2-12) failed. Both engine fan belts were off the pulley but only one was torn and elongated. Two hydraulic pump drive belts exhibited a distinct break. The outside edges of both belts were rounded indicating that they had turned on the pulleys. Apparently, when the cooling fan belt failed, it became wedged between the hydraulic pump pulley and the drive belts, turning the belts over.

Two failures of the cable assembly were recorded. The first failure occurred after 51.8 winch hours when the chain link connecting the chain to the cable failed (EPR K2-32). The failure occurred at the junction of the weld to the parent metal. Gas pockets were evident on the failure surface and the weld itself only covered approximately 80% of the surface. The second failure occurred after 57.1 winching hours, when one strand of the cable snapped (EPR K2-42). The cable was replaced and performed satisfactorily without failure for the remainder of the test.

Additional incidents were recorded that were directly related to the winch-recovery components. During winch operations, the cable failed causing the fairleader cable tensioner to rotate rapidly. The tensioner handle struck the mounting base and failed the tensioner eye-bolt (EPR K2-33). If the handle is either completely in the pay-out or pay-in position, the fairleader is able to rotate through a full circle without interference. Apparently, either the operator did not have the handle locked in the detent position or centrifugal force pulled the handle out of the detent position. The replacement-handle detent position was wider to provide a more positive lock (EPR K2-33s). The fairleader tensioner roller (EPR K2-37) and lower pulley (EPR K2-52) were replaced when a flat was found worn on both parts. Improper adjustment by the manufacturer on the friction pins did not allow the tensioner roller to rotate, allowing cable rubbing to wear the parts. The level-wind shaft collars that limit the travel of the pulley were found pushed against the trunnion caps (EPR K2-58). The setscrews that secure the collar were not effective to resist the side loading of the pulley. Weld cracks were found on the rear edge of the winch control valve bracket (EPR K2-60). The cable interfered with the forward spacer between the cable retainer wheels on the floating pulley (EPR K2-9). The spacer was relocated downward one mounting hole to eliminate the interference. After 50.9 hours of winch operation a groove was found worn in the fairleader bearing locking collar (EPR K2-23). The 1/8-inch deep groove was worn from cable scrubbing. The inboard pivot pin bushing for the right spade worked partially out of the mounting hole (EPR K2-15). The right hinge pin for the right personnel safety shield worked free (EPR K2-30). Vehicle vibration and the constant slamming of the safety shield against the ramp door both contributed to the pin working free. Cracks were found in the weld that secures the ramp safety chain eye to the right spade (EPR K2-17). With the spade in the embedded position, a crack propagated along both top edges of the eye after approximately 40.6 hours of winch operation with the ramp down and the chain holding the ramp. The outboard corners of both stoplight guards were found gouged from interference with the hook of the spade position cable in the travel position (EPR K2-16). After 3395 vehicle miles and 56.2 winch hours, one screw that secures the hydraulic pump mount loosened (EPR K2-41). The filament in the hydraulic-fluid temperature-warning light bulb was burned after 55.3 hours of winching operation (EPR K2-39).

Torque measurements of the winch, fairleader, and level-wind mounting bolts were recorded periodically throughout the test, EPR's K2-22, -43(22-2), -67(22-3). Table 2.19-III lists the recorded mounting bolt torque for various vehicle miles and winching hours. After each

series of torque readings were recorded, the bolts were torqued to specification. The miles and hours listed represent the operation completed between measurements.

Table 2.19-III. Winch Component Mounting Bolt Torques

Location	Specified, lb-ft	Measured, lb-ft Miles/Hours of Operation 1867/50.9	1881/8.0	347/41.9
Level-wind to mounting base	225-250			
Right front		240	250	250
Left front		230	250	240
Right rear		240	245	250
Left rear		240	250	210
Winch to winch mount	225-250			
Right front		100	-	250
Left front		50	-	250
Right rear		160	-	200
Left rear		160	-	240
Winch mount to mounting base	212-234			
Left (front to rear)				
1		170	230	190
2		220	230	195
3		215	205	210
Right (front to rear)				
1		150	230	230
2		170	230	230
3		75	230	225
Fairleader to mount	190-209			
Left (front to rear)				
1		165	175	200
2		170	190	150
3		205	209	150
Right (front to rear)				
1		170	209	195
2		170	209	150
3		200	195	150
Center (front)				
Left		205	205	140
Right		170	209	130
Fairleader mount to mounting base	107-118			
Front (left to right)				
Left		0	75	107
Center		70	70	115
Right		50	25	114
Rear (left to right)				
Left		50	115	100
Center		105	115	110
Right		85	115	108

Two defects were noted during the 12 hour crane durability test. After 3 hours, the locking nut that secures the packing in the pump handle socket worked loose allowing hydraulic oil to leak from the crane reservoir (EPR K2-47). Hydraulic fluid streamed from the cylinder pressure relief plug after 10.5 crane hours (EPR K2-48). Three defective areas were noted on the O-ring seal.

Two modifications were made to the test vehicle as received from the manufacturer. Prior to the start of testing a retainer chain for the hydraulic tank cover was installed with a clamp around the tank filler neck prior to testing operations as per the manufacturer's instructions and approval by USATACOM. The retainer was installed to eliminate the possibility of losing the cover, and reducing possible hydraulic fluid contamination from placing the cover on a dirty surface (EPR K2-6). After 3649 vehicle miles and 58.9 winch hours, a hydraulic fluid temperature gage was installed on the hydraulic tank (EPR K2-44). Both modifications were satisfactory for the period tested.

During the winch endurance phase of testing, fuel mixed with burnt carbon seeped from the joints of the exhaust manifold and collected on the right sponson in the engine compartment (EPR K2-18). This condition was only evident during prolonged periods of winching operation when the engine idled frequently for long periods. The leakage from the exhaust manifold ceased when the vehicle was driven. Although this condition was evident during testing, it is unlikely that actual field usage will require similar excessive idling.

The most noteworthy incidents during the vehicle-endurance phase of testing occurred during towing operations. The basic M113A1 tow pintle failed repeatedly during the scheduled 1000 miles of towing operations. Table 2.19-IV lists the pintle failures and the accumulated mileage between failures.

Table 2.19-IV. Pintle Failures on XM806E1 Towing M113A1 Weighing 23,400 Pounds

Failure	Towed Mileage per Failure
1	39 miles, level cross-country
2	59 miles, level cross-country
3	247 miles (178 miles level cross-country, 69 miles hilly cross-country)

The first pintle failure was the result of a side load on the locking jaw (EPR K2-24). One ear of the lockjaw was bent and the hinge pin was sheared. The second pintle failed because of an impact loading on the pintle (EPR K2-28(24-2)). The pintle shaft was found broken adjacent to the locking nut along the inside surface of the ramp.

The failed surface indicated a tensile failure without indication of metal fatigue. The third failure was the result of a similar side loading reported for the first failure (EPR K2-31(24-3)). No additional pintle failures occurred during the remaining 669 miles primarily over paved and gravel terrain.

After 972 miles of towing operation, a 4-inch hairline crack was found on the exterior face of the ramp (EPR K2-49). The crack propagated along the left weld for the ramp center hinge support rib. The crack did not impair vehicle towing operation.

Additional M113A1 basic components were found defective during the 4035 miles of vehicle operation. Two shock absorbers were replaced; the right front after 1802 miles (EPR K2-27) and the left rear after 3395 miles (EPR K2-40). The drive sprockets were reversed after 2084 miles of which 327 miles were with a towed load (EPR K2-29). The sprockets were replaced after an additional 505 miles all of which was with a towed load (EPR K2-34). The replacement sprockets were operated for 1431 miles, of which 172 miles were with the towed load, before they were worn sufficiently to warrant reversal (EPR K2-54). After 3649 test miles, with all the towing operation completed, 36 track shoes were found extensively cracked (EPR K2-46). The right number one torsion bar failed inside of the right spline after 1802 vehicle miles (EPR K2-26).

The larger tow pintle (7760103) that replaced the standard M113A1 tow pintle (51116-1) was tested for 1024 miles over the courses listed in Table 2.19-V.

Table 2.19-V. Vehicle Operation with Large Tow Pintle

Course	Miles
Perryman, level cross-country	272
Churchville, hilly cross-country	266
Paved, primary road	234
Gravel, secondary road	252
Total	1024

The new pintle installation required a larger ramp hole and four additional parts (EPR K2-70).

Several vehicle components were replaced during the additional 1024 miles of operation. Twenty-nine track shoes were found with at least one crack and five shoes were found with damaged bushings (EPR K2-73(46-2)). Three road wheels were replaced because the steel wear-plate rivets were sheared and the plates gouged (EPR K2-72). The rubber bumper for the right front road wheel was pulled from the backing

plate (EPR K2-74). Dirt and water were found in the right number one road wheel arm assemblies (EPR K2-75). The seals and bearings were replaced.

The lock washers were installed on the left sprockets and carrier (EPR K2-64) per TECOM letter, Appendix VI. The bolts were checked three times during the 1014-mile test. There was no appreciable difference between the torque for bolts with and without lock washers.

A total list of the deficiencies and shortcomings appears in Appendix IV.

Fuel consumption for the various test courses and winch operation is listed in Table 2.19-VI.

Table 2.19-VI. Fuel Consumption of XM806E1 Vehicle with and without M113A1 in Tow

Course or Function	Fuel Consumption, mpg Without Towed Load	With Towed Load
Perryman	2.16	1.15
Churchville	2.14	1.28
Paved	2.99	1.77
Gravel	2.26	1.44
Winch operation	[a]0.22	-

[a]Operating hours per gallon.

During endurance operations, 123 quarts of engine oil were added. The oil was added on the average of 57.2 miles per quart as an independent carrier; 55.9 miles per quart with a towed load; and 4.2 winch hours per quart.

2.19.5 Analysis

The addition of the recovery equipment to the basic M113A1 vehicle did not degrade the durability of the standard carrier. The failure incidents reported for the common M113A1 parts were similar to that normally experienced during a typical M113A1 duty cycle.

Failure to maintain a satisfactory degree of quality assurance was responsible for several component failures. Analysis of the failed winch stage-three spur gear indicated a material weakness. The magnaflux inspection of a new winch assembly revealed grinding checks on the face of the second stage sun gear. The winch is a government furnished item to the manufacturer for addition of the grooved drum (The P30 winch

is used for the boom in the M578 recovery vehicle.) The quality assurance of the counterbalance valve is the responsibility of the XM806E1 manufacturer. A similar incident was reported during the M113 recovery vehicle test (Appendix VII, Reference 3).

If the hydraulic pump drive belts had not failed when the engine cooling fan belts failed, the operator would not have been aware of impending damage to the engine. The winch operator's view of the engine instrument panel is obstructed. In lieu of providing warning lights for excessive engine temperature and low oil pressure in view of the winch operator, the operator's manual should require that a crew member remain in the driver's compartment to monitor the vehicle instrument panel.

The level wind modifications since the M113 recovery vehicle test have apparently improved the life of the floating pulley and the cable. The life of both components has been increased. However, the modifications were only one contributing factor since line pull has been significantly reduced (par. 2.17). In general, the cable under normal usage should experience a life from 50 to 60 hours.

The fairleader cable tensioner handle interference with the mount caused the reported damage to the eye-bolt. This interference was also reported during the M113 recovery vehicle test. The cheater bar, provided as OVE, is required to rotate the tensioner handle. The operation would not be altered if the tensioner handle were shorter to eliminate the interference.

The M548 type tow pintle was sufficiently durable for 1024 towing miles.

The manufacturer's attempt to eliminate bolt loosening of the winch components, reported during the M113 recovery kit test, by providing larger diameter bolts with increased torque was unsatisfactory. The organizational maintenance manual should provide for a periodic check of bolt torque.

Engineering Change Proposals (ECP) and future Engineering Orders (EO) have been initiated. Table 2.19-VII list includes those proposals:

Table 2.19-VII. Change Proposals and Engineering Orders

Item	ECP - EO
Large tow pintle (M548-type)	D9969
Hydraulic temperature gage	D9762
Winch control-valve bracket	E1134
Modified stoplight guard	R9969

The proposals as well as an improved quality control should be incorporated in future vehicles.

2.20 MAINTENANCE EVALUATION

2.20.1 Objective

The objective was to evaluate the practicability, the ease of performance, man-hour requirements for scheduled and unscheduled maintenance, and adequacy of the maintenance package with regard to direct support and general support.

2.20.2 Criteria

Criteria are as follows:

a. M113A1 military specification, Reference 1, par. 3.2.1.

b. XM806E1 ATPD, Reference 2, par. 3.2.1.

c. Comparison with M113A1.

d. Comparison with M113 recovery vehicle, Reference 3.

2.20.3 Method (MTP 2-2-503)

Scheduled maintenance was conducted in accordance with instructions supplied with the vehicle.

Maintenance analysis was developed by identifying and recording all maintenance time required during testing. The evaluation provided judgment in the cancellation or adjustment of the data on failures of components that were known to have been corrected before the conclusion of the test.

Maintenance analysis was based on maintenance man-hours, ratio of man-hours to total operating hours, maintenance time, and ratio of maintenance time to operating hours.

The maintenance man-hours and maintenance time are compiled using the following breakdown:

a. Maintenance performed on standard vehicle components.

b. Maintenance performed on the winch components.

c. Maintenance performed on the crane components.

d. The total of a, b, and c.

2.20.4 Results

A total of 392.2 hours of operation was required to complete the 4035 vehicle miles, 100.9 winch hours and 12 crane hours. The average vehicle speed was 14.45 miles requiring 279.3 hours of operation.

Total maintenance, scheduled and unscheduled, amounted to 148.3 man-hours which was 38% of the total 392.2 hours of operation. In terms of vehicle hours, the total maintenance time was 25.4% of the total operational hours. Scheduled maintenance (reversing sprockets, inspections and lubrication) required 68.6 man-hours and unscheduled maintenance 79.7 man-hours. The unscheduled maintenance was divided between 37.4 man-hours for the vehicle, 41.7 man-hours for the winch, and 0.6 man-hours for the crane. General support maintenance for the winch required 32 of the 41.7 man-hours.

The unscheduled maintenance expended on the basic vehicle and recovery components were due to the failures listed in Appendix V. Appendix V also includes a maintenance summary sheet.

2.20.5 Analysis

Subparagraph (b) of both criteria requires that: "Vehicle shall require no replacement or major overhaul of any major automotive component during 4000 miles of normal operation." The XM806E1 successfully met the criteria if only the strict compliance of automotive is followed. However, the winch is a major component for the completion of the mission of the XM806E1. Considering the general support repairs for the winch gear train, the test vehicle did not meet the criteria.

The winch unscheduled maintenance for the M113 recovery vehicle Appendix VI (Reference 3), was 33.8 man-hours compared to the 41.7 man-hours for the XM806E1. The largest part of the XM806E1 maintenance was the 32 man-hours required to repair the winch gear train. The crane unscheduled maintenance of 2.2 man-hours for the M113 recovery vehicle was reduced to 0.6 man-hours for the XM806E1. It is inappropriate to compare the vehicle unscheduled maintenance between the M113 recovery vehicle and the XM806E1, since the M113 was rebuilt prior to test and the XM806E1 was a new production vehicle.

Maintenance per operating hour for the entire XM806E1 was less than the maintenance required for a basic M113A1, USA Reg No. 12FT03, (USATECOM Project No. 1-4-2620-06) during a 3848-mile test. Table 20-I lists the maintenance requirements of the XM806E1 and the M113A1.

Table 20-I. Maintenance Requirements of XM806E1 and Standard M113A1

	XM806E1	M113A1
Scheduled maintenance, vehicle hours	53.6	30.0
Unscheduled maintenance, vehicle hours	46.0	48.5
Maintenance man-hours per operating hour, man-hours	0.38	0.48
Average length of each stoppage, vehicle hours		
Organizational (driver)	0.10	0.16
Organizational scheduled	1.12	1.82
Organizational unscheduled	0.78	0.87
Direct and general support	16.0	1.70
Total vehicle down time per operating hour	0.12	0.22
Total vehicle maintenance hours per operating hour (not to be confused with maintenance man-hours)	0.25	0.36

The higher scheduled maintenance time for the XM806E1 occurs because the winch requires periodic scheduled maintenance, e. g., cable maintenance. The lower unscheduled maintenance time for the XM806E1 is probably attributable to product improvements and MWO's which have been incorporated since the early 1966 test of the M113A1.

2.21 HUMAN FACTORS

2.21.1 Objective

The objective was to determine the suitability of the seating, visibility, arrangement of controls, instrument displays, entry and exit for all personnel, and general comfort to include noise level, vibration response, and vehicle pitch, bounce, and stability.

2.21.2 Criteria

Comparison with M113 recovery vehicle, Reference 3.

2.21.3 Method (MTP-2-2-803)

A human factors review of the vehicle was made under both static and dynamic conditions, with primary emphasis on the winch and crane. The review was integrated with planned testing. Specific items considered with regard to human safety, comfort, efficiency, and ease of operation included the following:

a. Space requirement for ease of operation and maintenance.

b. Control display relationships.

c. Work space layout.

d. Safety in operation and maintenance.

e. Environmental factors such as temperature, humidity, dust, noise, and vibration.

f. Communication.

g. Readability of such items as dials and meters.

h. Comfort, which may significantly affect efficiency of operation and personnel.

i. An accumulation of nauseous and irritating fumes in an amount that has an effect on personnel.

2.21.4 Results

The test vehicle over-the-road operational characteristics appeared similar to a basic M113A1 APC. Since latch openings and

basic hull configuration were the same as the standard carrier, toxic fumes and noise-level studies were not conducted.

The crane pump handle operational force was excessive for heavy loads (par. 2.18).

In general, the winch components were readily accessible for maintenance and operation within the imposed space limitations of the personnel compartment.

2.21.5 Analysis

Several improvements were made on the XM806E1 since the M113 recovery vehicle test. The walk-way to the left of the winch was improved by the relocation of the fire extinguisher and rifle mounting bracket. The center stowage-tray congestion was satisfactorily alleviated by relocating the snatch blocks and crow bars. A personnel safety shield was provided to the left side to afford the winch operator maximum protection. The center spade locking pins provide for rapid assembly with the side spades. A cheater bar was provided for the winch control handle to reduce operator fatigue for prolonged winch operations.

Vehicle maintenance was made easier by the addition of rosan inserts in the hull channel supports for the winch mount. The access hole in the sheet metal assembly over the winch left side facilitated lubrication of the winch drum.

The force required on the crane pump handle is excessive for a continuous lift of a maximum rated load. However, it is unlikely that field usage will require a continuous effort. Power pack removal is a slow operation requiring only intermittent lifts and the crane can be successfully employed.

2.22 FINAL INSPECTION

2.22.1 Objective

The objective was to determine the condition of the vehicle at the end of test and predict to some degree the ability of the vehicle to continue in service.

2.22.2 Criteria

Not applicable.

2.22.3 Method

Visual inspections were made of the vehicle suspension, hull, crane and associated winch components. The hydraulic pump flow rate was measured. The winch was completely disassembled and magnafluxed. A magnaflux inspection was also made of the levelwind floating pulley.

The transmission was disassembled and the clutch plates were measured for wear. All worn plates were replaced according to the criteria for the transmission in TM 9-2520-254-3/5.

The vehicle was reassembled and operated for an additional 1000 miles to evaluate the durability of a stronger tow pintle (Appendix VI).

After the additional 1000 miles of operation, the vehicle was inspected. Visual inspections were made of the suspension and hull in the area of the ramp door. The transmission was disassembled and clutch plate wear recorded.

2.22.4 Results.

The magnaflux inspection of the winch components revealed only one defective assembly. Cracks were found on the stage-one carrier planetary gears (EPR K2-79). At least one crack was found on each of the three gears propagating along the tooth root. The cracks were approximately 1/2 inch in length, which represents one half of the gear width.

The magnaflux inspection also revealed cracks in the levelwind floating pulley spoke ribs (EPR K2-80). The spoke rib cracks were evident on both sides of each spoke near the pulley hub.

Visual inspections revealed additional defects directly attributable to winch or crane operations. The inboard surface of the right fender was found cracked (EPR K2-62). The crack propagated along the rear of the short vertical weld and at a 45° angle from the weld into the fender. The stress induced when the side spades are embedded caused the crack. A weld crack was observed propagating along the top and front of the left front fairleader channel hull mount (EPR K2-63). The top crack propagated through the weld to the underside of the floor plate crossmember. The setscrew that secures the levelwind floating pulley shaft to the trunnion cap was found broken (EPR K2-81). The failure appeared to be the result of an excessive torque when the levelwind was initially assembled because the failure occurred the thickness of the jam nut from the top of the screw. The fairleader casting pilot hole for the guide roller was elongated 0.050 inch during the 100.8 hours of winch operation (EPR K2-76). The wear did not degrade the performance of the cable tensioner.

The crane was disassembled and inspected. The internal components showed only minimal wear. However, some wear was evident on the boom and hydraulic cylinder pivot pin mounting holes (EPR K2-77). The boom pivot-pin hole was worn 0.050-inch. The hydraulic cylinder upper pivot pin mounting hole 0.015 inch and the hydraulic lower pivot pin mounting hole 0.025 inch. The wear did not degrade the operation of the crane.

The winch hydraulic-system components were all disassembled and inspected. Visual wear was not evident in the control valve, counterbalance valve, motor, or pump. The hydraulic fluid flow rate was measured during initial inspection and after 100.8 hours of winch operation. The results appear in Table 2.22-I for various engine speeds and line pressures.

Table 2.22-I. Hydraulic Pump Flow Rate

Operating Condition		Flow Rate, gpm	
Pressure, psi	Engine Speed, rpm	Initial Inspection	Final Inspection
0	580	7.0	8.1
0	1320	16.0	18.0
0	1800	22.0	25.0
0	2000	26.5	27.3
1000	550	6.0	5.9
1000	950	10.0	9.3
1000	1120	13.0	12.3
1000	1610	18.0	18.8
2000	550	5.0	5.0
2000	850	7.5	7.5

Several M113A1 components were found defective; however, the defects were attributable to the basic vehicle and not to the addition of the recovery components. The right number one torsion bar was found broken immediately inward of the anchor splines (EPR K2-65(26-2)). All the rubber was missing from the left inboard number four road wheel (EPR K2-66). The left and right number 1 road wheel housing seals were leaking from dirt accumulation on the sealing surface (EPR K2-68). The right front shock absorber was leaking (EPR K2-69(27-2)). The generator drive pulley was found to have an excessive amount of backlash (EPR K2-71). The drive shaft splines were serviceable with only minimal wear evident. The pulley was in operation for over 4000 vehicle miles and 100.8 hours of winch operation.

The transmission wear criteria in TM 9-2520-254-3/5 states that the original thickness of 0.150 to 0.156 inch for the bronze rotating friction plates can be worn to a thickness of 0.145 inch before replacement and that the externally splined steel plates are acceptable until the dish exceeds 0.005 inch. After 4035 miles of vehicle operation

100 miles of which were with an M113A1 in tow, only clutch plates in the low and intermediate ranges showed signs of wear (EPR K2-61). All the steel plates in the intermediate range and three steel plates in the low range exceeded the dish criteria and were replaced. Although the bronze plates in these ranges were worn, according to the criteria, they were still serviceable. The more noticeable wear in the low and intermediate ranges is directly attributable to towing operations.

The test vehicle was operated for an additional 1024 miles to evaluate the durability of a stronger tow pintle.

Table 2.22-II indicates the clutch plate wear during the 1024 miles with an M113A1 in tow. The plates are listed in order from the apply piston with B denoting bronze plates and S denoting steel plates.

Table 2.22-II. Clutch Plate Wear

Position	Clutch Plate Measurements Prior to 1024 Miles of Towing Operation		Clutch Plate Measurements after 1024 Miles of Towing Operation		Remarks or Condition
	Dish, in	Thickness, in.	Dish, in.	Thickness, in.	
High range					
1B	0.000	0.152	0.001	0.152	Good
2S	.000	.093	.005	.093	Good
3B	.000	.153	.001	.153	Good
4S	.000	.093	.002	.093	Good
5B	.000	.1535	.002	.153	Good
6S	.002	.093	.002	.093	Good
7B	.000	.153	.001	.1525	Good
8S	.000	.2975	.000	.2975	Good
Intermediate range					
[a]1S	.002	.095	.033	.095	Warped
2B	.002	.150	.040	.140	Worn and pitted
[a]3S	.002	.0935	.015	.093	Warped
4B	.004	.146	.009	.143	Worn and pitted
[a]5S	.002	.094	.090	.094	Warped and elongated
6B	.002	.149	.030	.143	Worn and pitted

[a]New clutch plates installed prior to 1024 miles of towing. All other plates experienced a life cycle of 5080 test miles, of which 2024 miles were with an M113A1 in tow.

Table 2.22-II (Cont'd)

Position	Clutch Plate Measurements Prior to 1024 Miles of Towing Operation: Dish, in.	Thickness, in.	Clutch Plate Measurements after 1024 Miles of Towing Operation: Dish, in.	Thickness, in.	Remarks or Condition
Low range					
[a]1S	0.000	0.915	0.008	0.915	Slight heat marks
2B	.007	.152	.007	.142	Worn on one side
[a]3S	.005	.095	.120	.095	Heat marks, elongated
4B	.002	.151	.008	.140	Worn and pitted
[a]5S	.004	.095	.008	.0945	Warped and elongated
6B	.002	.152	.010	.146	Worn and pitted
7S	.002	.095	.020	.095	Warped
Reverse range					
1S	.002	.094	.001	.094	Good
2B	.000	.153	.004	.152	Good
3S	.004	.094	.004	.094	Good
4B	.003	.152	.001	.152	Good
5S	.005	.095	.005	.0945	Good
6B	.000	.154	.000	.153	Good
7S	.000	.094	.003	.094	Good
8B	.002	.151	.001	.151	Good

[a]New clutch plates installed prior to 1024 miles of towing. All other plates experienced a life cycle of 5080 test miles, of which 2024 miles were with an M113A1 in tow.

Three steel plates were found elongated (egg-shaped) and heat scored (EPR K2-82(61s)). The inside diameter of a new steel plate is 7.183 inches. The elongation and the plate position was as shown in Table 2.22-III.

Table 2.22-III. Elongation and Position Data

Position	Minimum Diameter, in.	Maximum Diameter, in.
Intermediate range		
5S	6.863	7.172
Low range		
3S	6.914	7.203
5S	6.900	7.121

During the first 4035 miles of operation, wear was not excessive, however, some pitting was evident. The additional 1024 miles of towing accelerated the wear rate. The steel plates experienced a temperature rise from the increased clutch slippage as the bronze plates became worn. The low range plates were sufficiently elongated under the applied heat to damage the the low range clutch hub.

A 4-inch-long hair line crack was found on the exterior face of the ramp along the left weld of the center hinge support rib (par. 2.19). After the additional 1024 miles of towing, the crack extended 1-1/8 inches from the outside diameter of the ramp pintle holw downward 6-3/8 inches (EPR K2-84(49s). Hence, the additional towing increased the crack only 2-3/8 inches in length. No other defects in the ramp or hinge pins were found.

Several additional defects were observed after the final inspection. Two weld cracks were found on the forward vertical rib of the hydraulic pump bracket (EPR K2-91). Examination revealed minimal weld penetration into the parent metal. Only four of 12 springs in the engine drive coupling were found to be in satisfactory condition (EPR K2-83). Three springs had broken and fallen from the mount and five springs remained in the mount but were broken. The broken springs were at the bottom of the flywheel housing. The oil coolant outlet gasket failed causing a water coolant leak which amounted to a loss of two to three gallons during eight hours of operation (EPR K2-85). The lower bushing for the right rear shock absorber was worn excessively (EPR K2-88) and subsequently damaged the road wheel arm mounting pin (EPR K2-89). The bushing seals were also found worn (EPR K2-90).

2.22.5 Analysis

Several significant defects noted during the final inspection of the M113 recovery vehicle (Appendix VII, Reference 3) were also found on the XM806E1. The re-occurring defects were: fender cracks, fairleader channel-mount weld crack, levelwind setscrew failure and levelwind pulley-spoke cracks. The failures after the current test were not as severe as the M113 recovery vehicle test, i.e., only one fender was cracked compared to two, the floating-pulley life was increased approximately 50 hours. However, the cable loading has been significantly reduced (par. 2.17).

The fairleader hull-mount design will be changed to a full-length channel rather than the present design of three short channel section as per ECP - EO E1195.

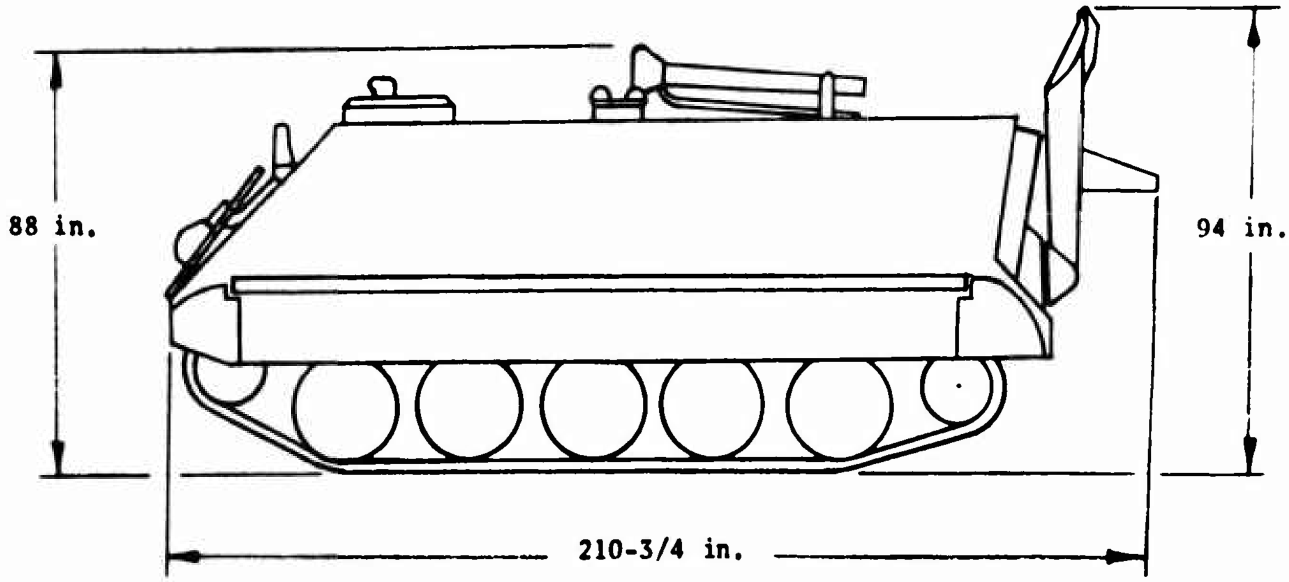
All the defects cited above were reported as shortcomings. The vehicle was operational prior to the final inspection and the defects did not limit the efficiency of the test vehicle. It is likely that the test vehicle could have continued in operation, however, it is difficult to assess how long operation could have continued before the defects would become severe enough to halt operation.

The transmission wear after 4035 miles of vehicle operation, 1000 miles of which were with a M113A1 in tow, was satisfactory. When the vehicle is scheduled for rebuild, all clutch plates should be replaced. The wear rate is accelerated if any worn plates are reused as was indicated by the additional 1024 miles of towing.

SECTION 3. APPENDICES

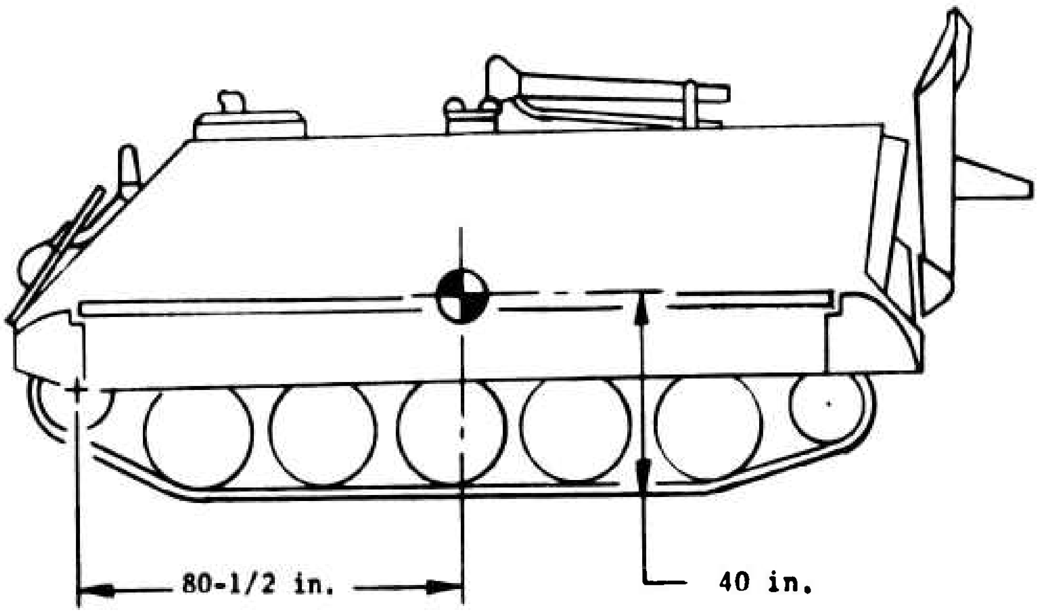
APPENDIX I - TEST DATA

Basis Dimensions of XM806E1 Recovery Vehicle

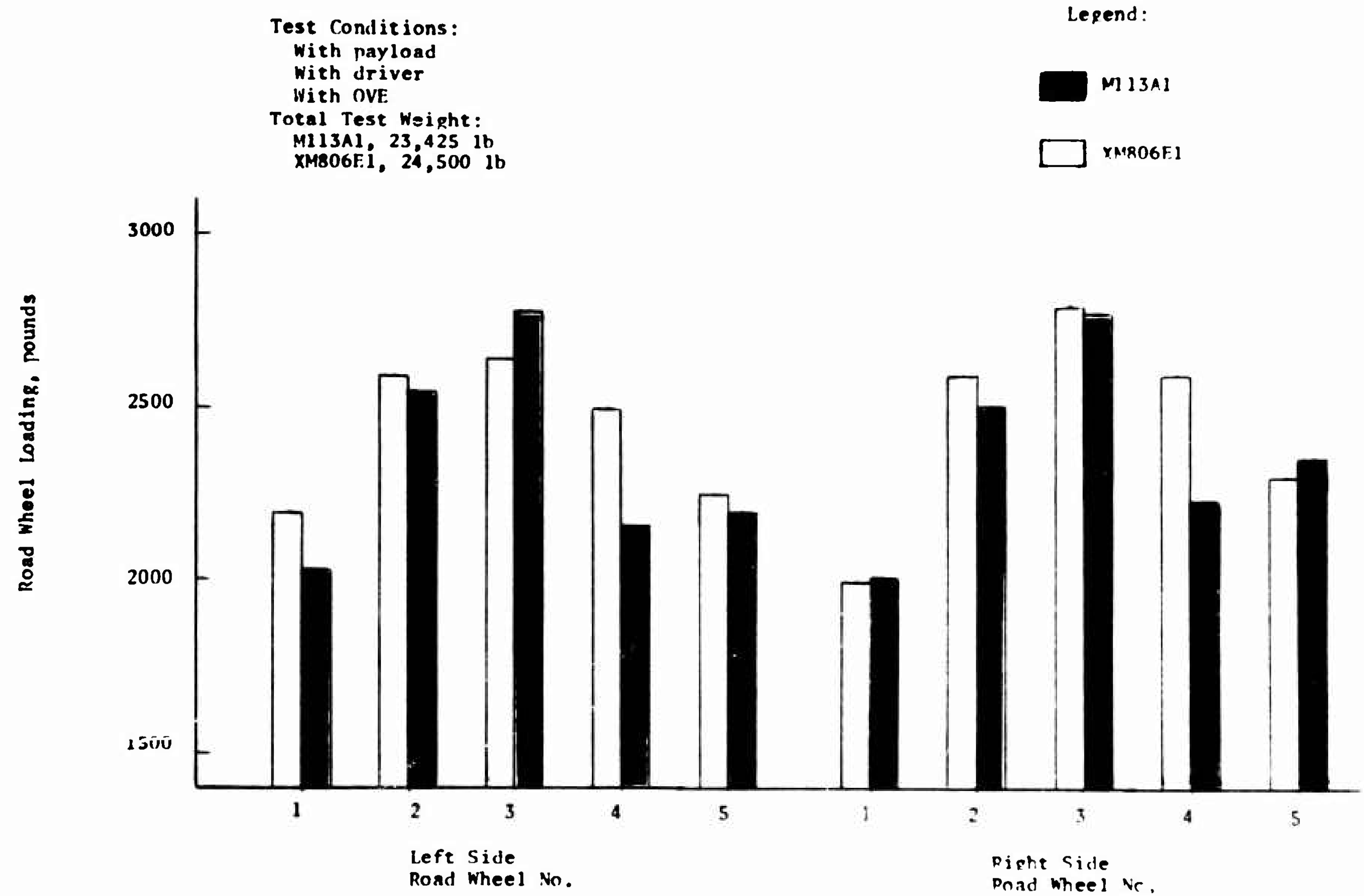


Maximum Width (Track Shield to Track Shield), 105-1/2 Inches

Center of Gravity for XM806E1 Recovery Vehicle Weighing 24,500 Pounds



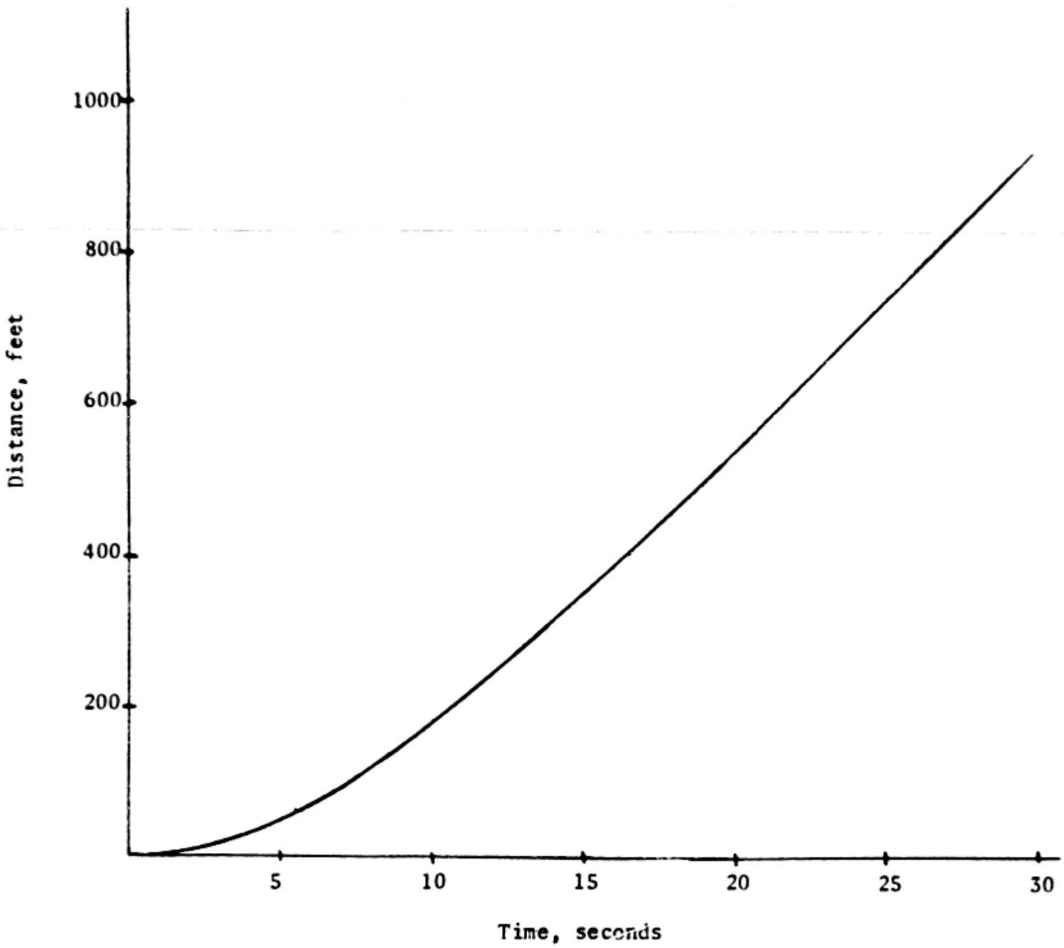
The Lateral Center of Gravity Is 1/4 Inch to
the Right of the Vehicle Centerline



Weight Distribution of M113A1 versus XM806E1

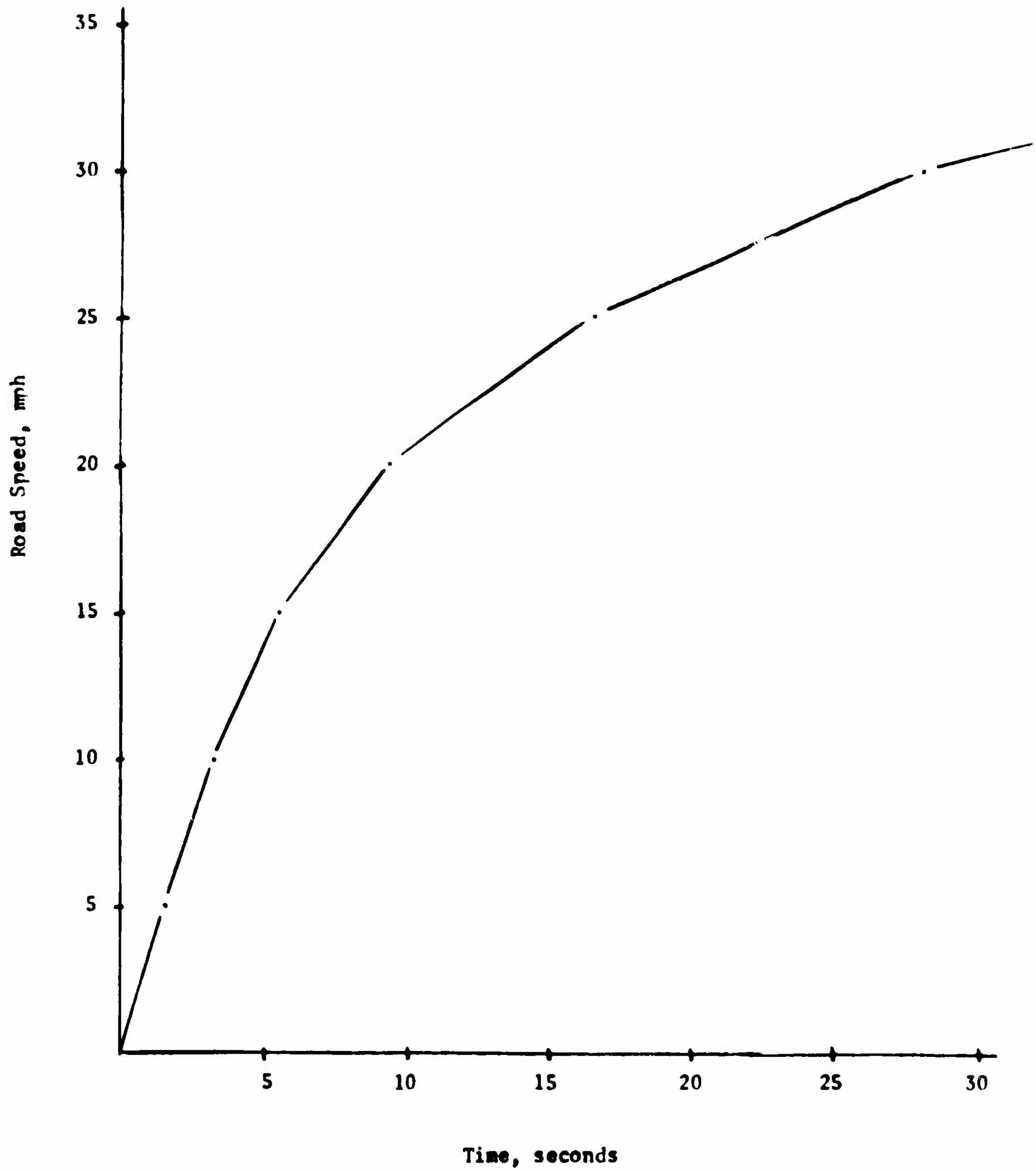
Acceleration (Time-Distance) Characteristics of Test Vehicle

Engine: Model No. 6V53
Transmission: Model TX-100-1
Steer Unit: Model No. DS-200
Test Weight: 24,500 Lb



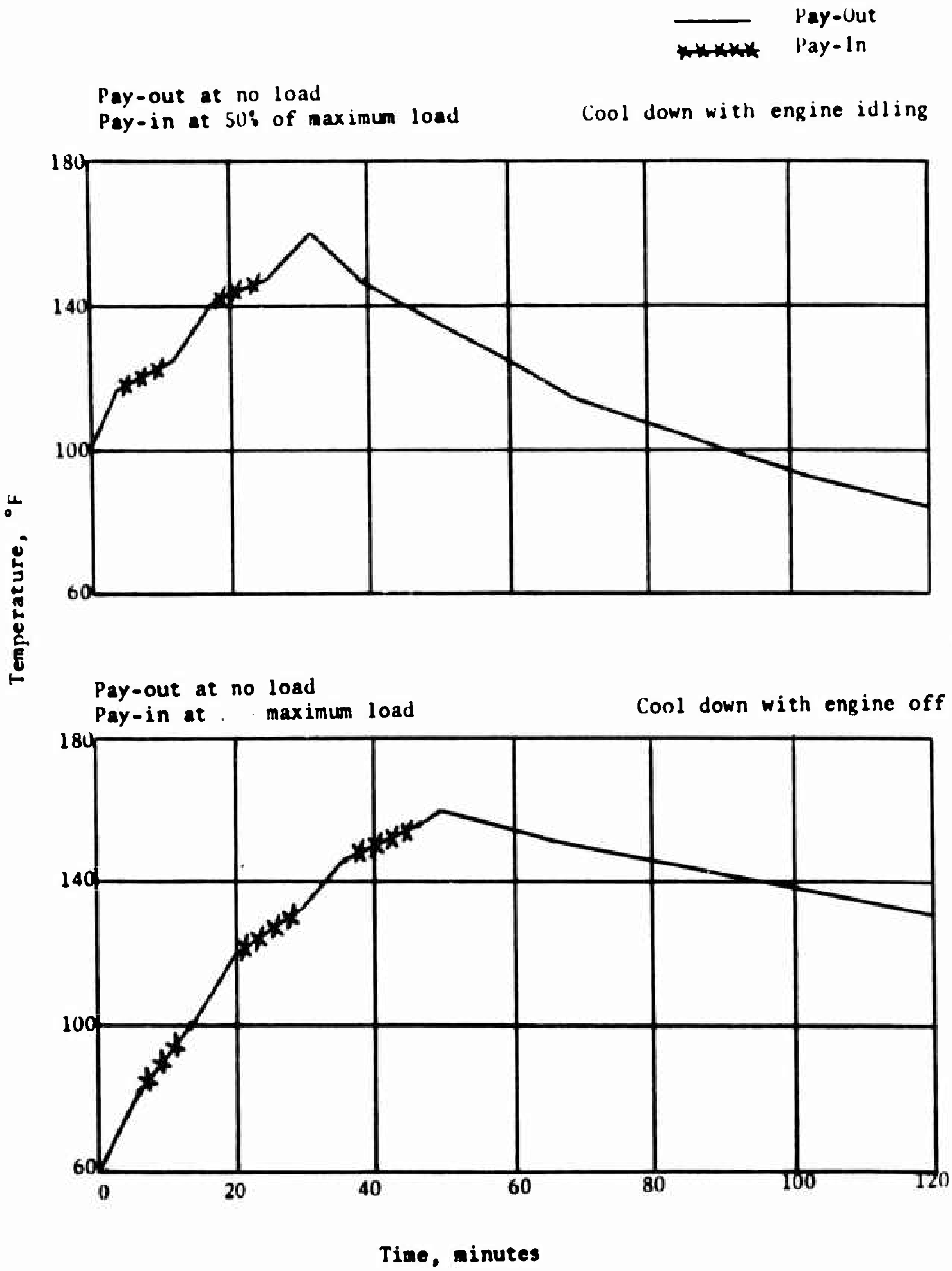
Acceleration (Time-Velocity) Characteristics of Test Vehicle

Engine: Model No. 6V53
Transmission: Model TX-100-1
Steer Unit: Model No. DS-200
Test Weight: 24,500 Lb



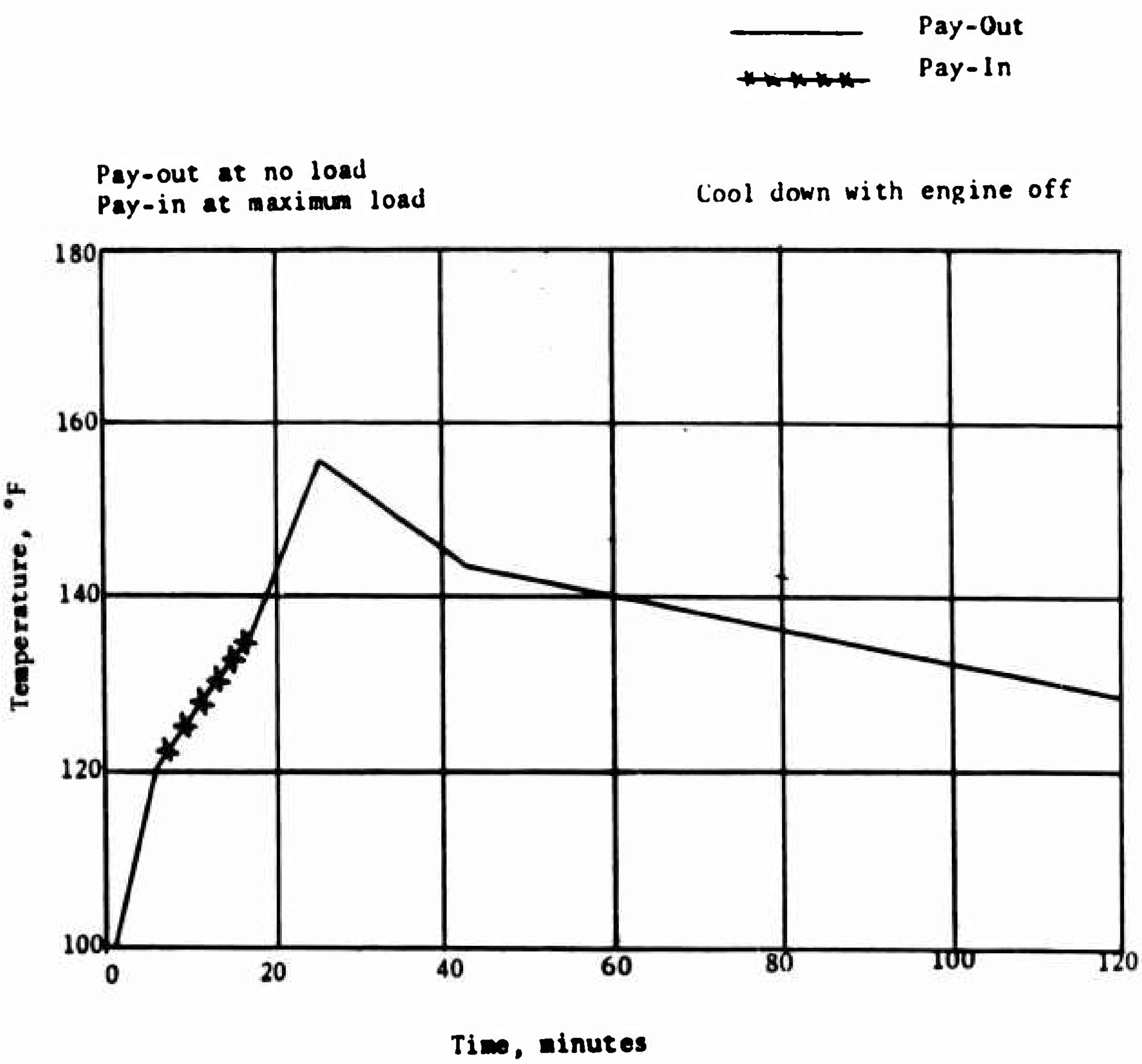
Hydraulic Oil Time-Temperature Characteristics

Ambient Temperature - 30°F



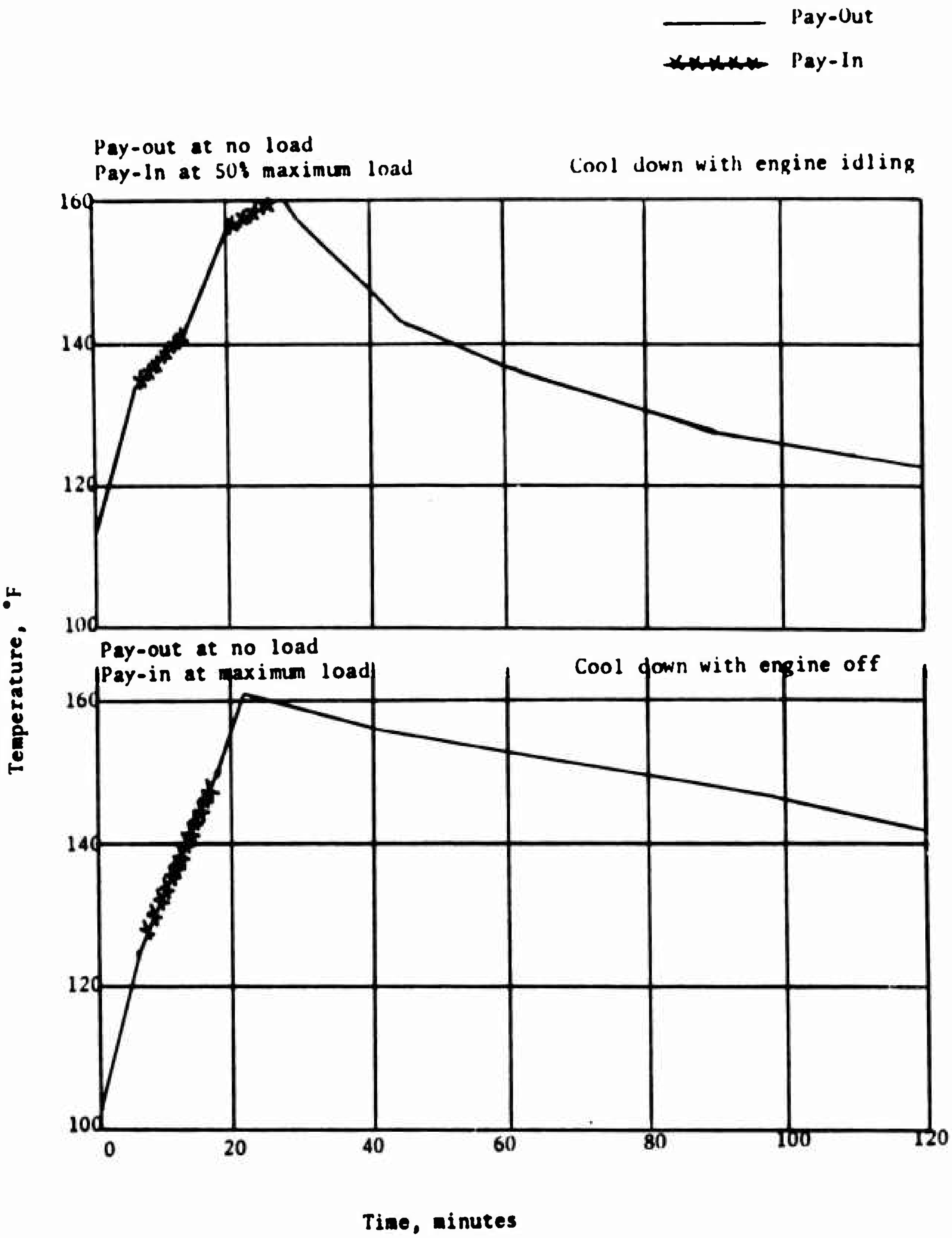
Hydraulic Oil Time-Temperature Characteristics

Ambient Temperature - 85°F



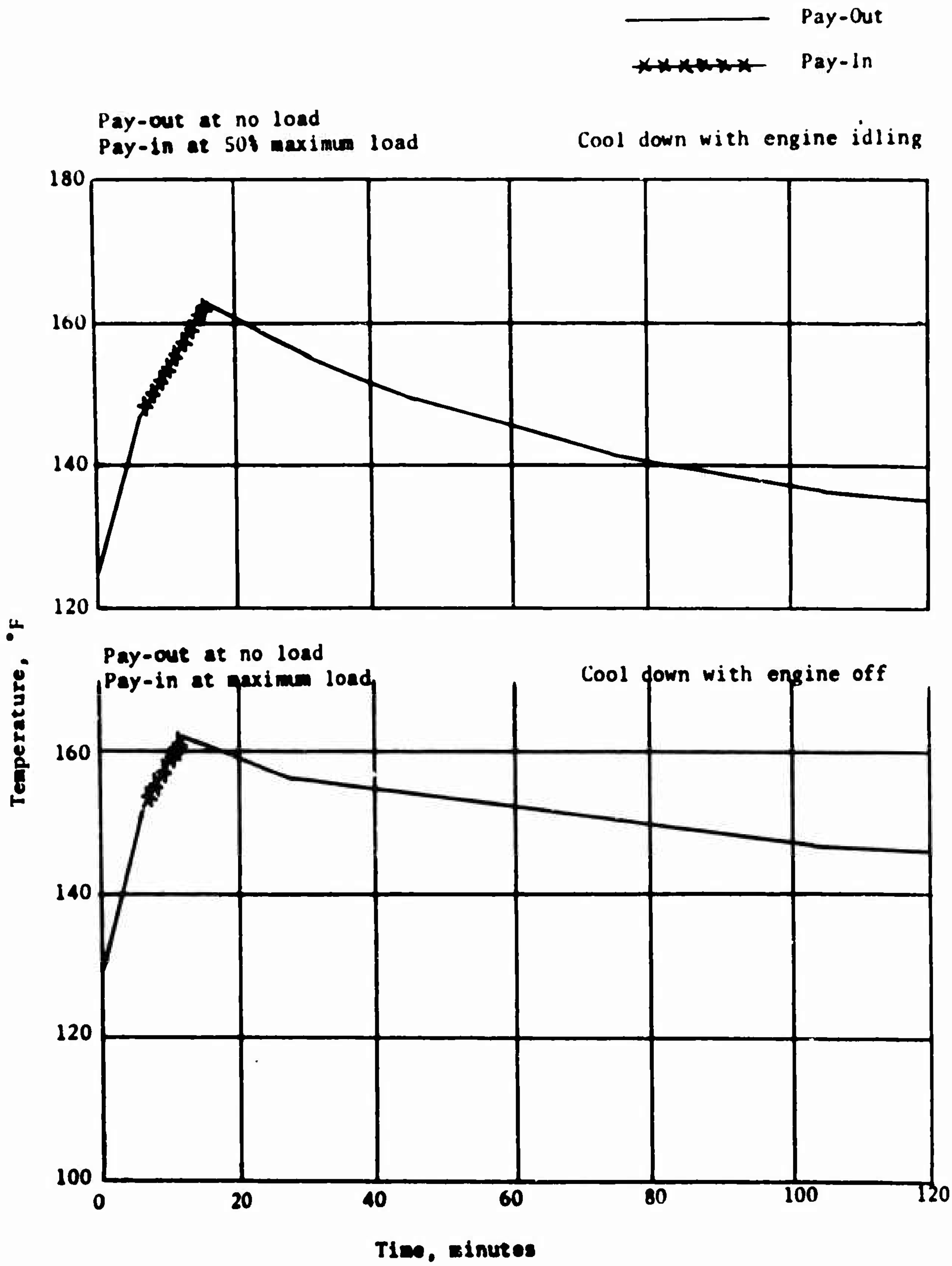
Hydraulic Oil Time-Temperature Characteristics

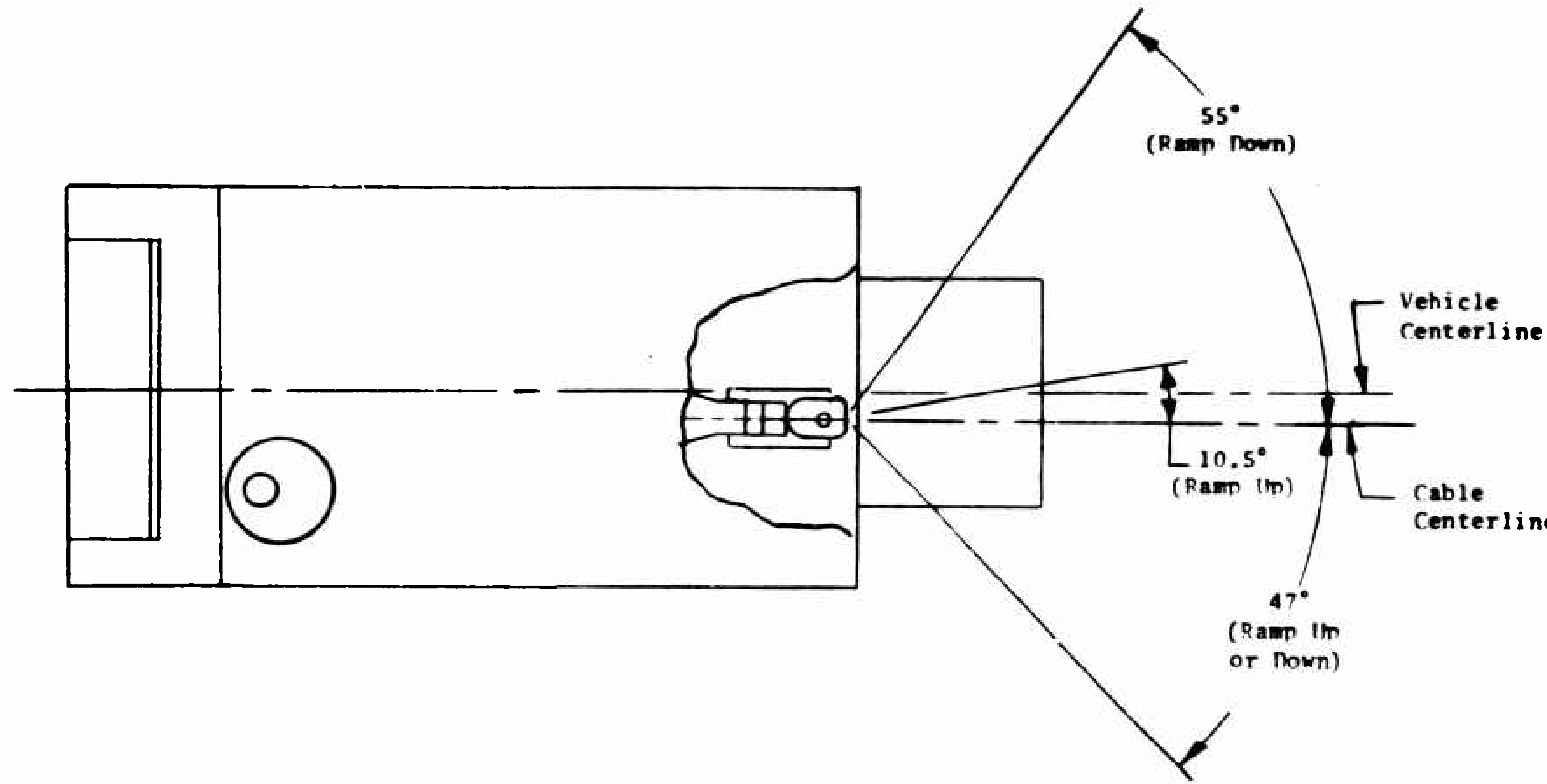
Ambient Temperature - 100°F



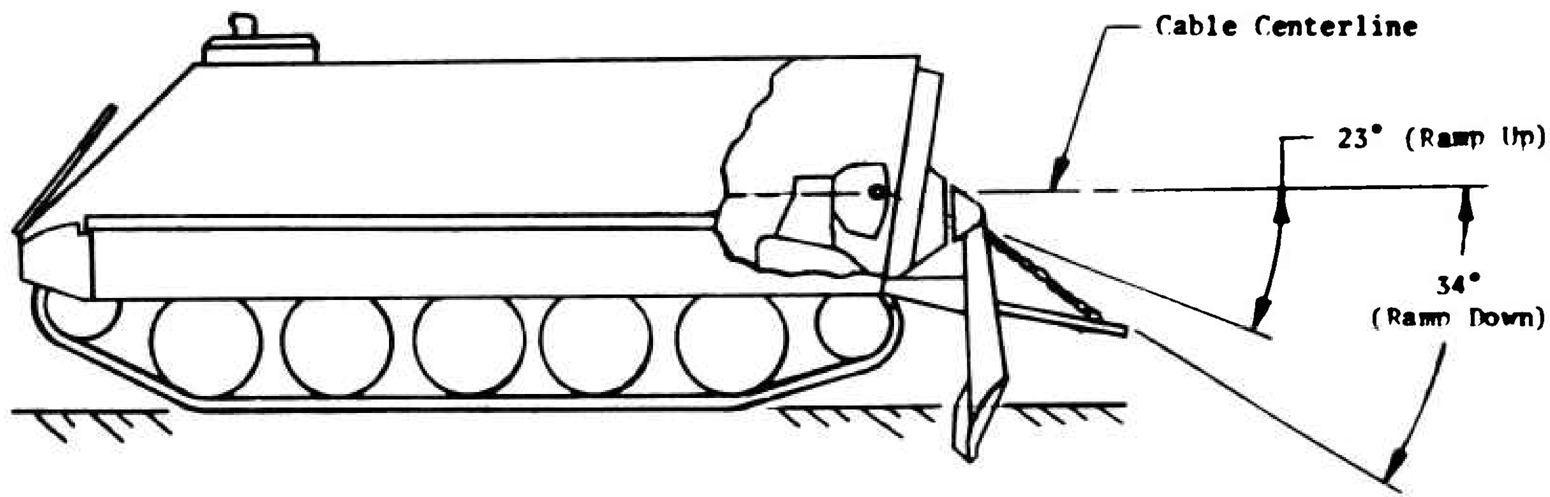
Hydraulic Oil Time-Temperature Characteristics

Ambient Temperature - 120°F

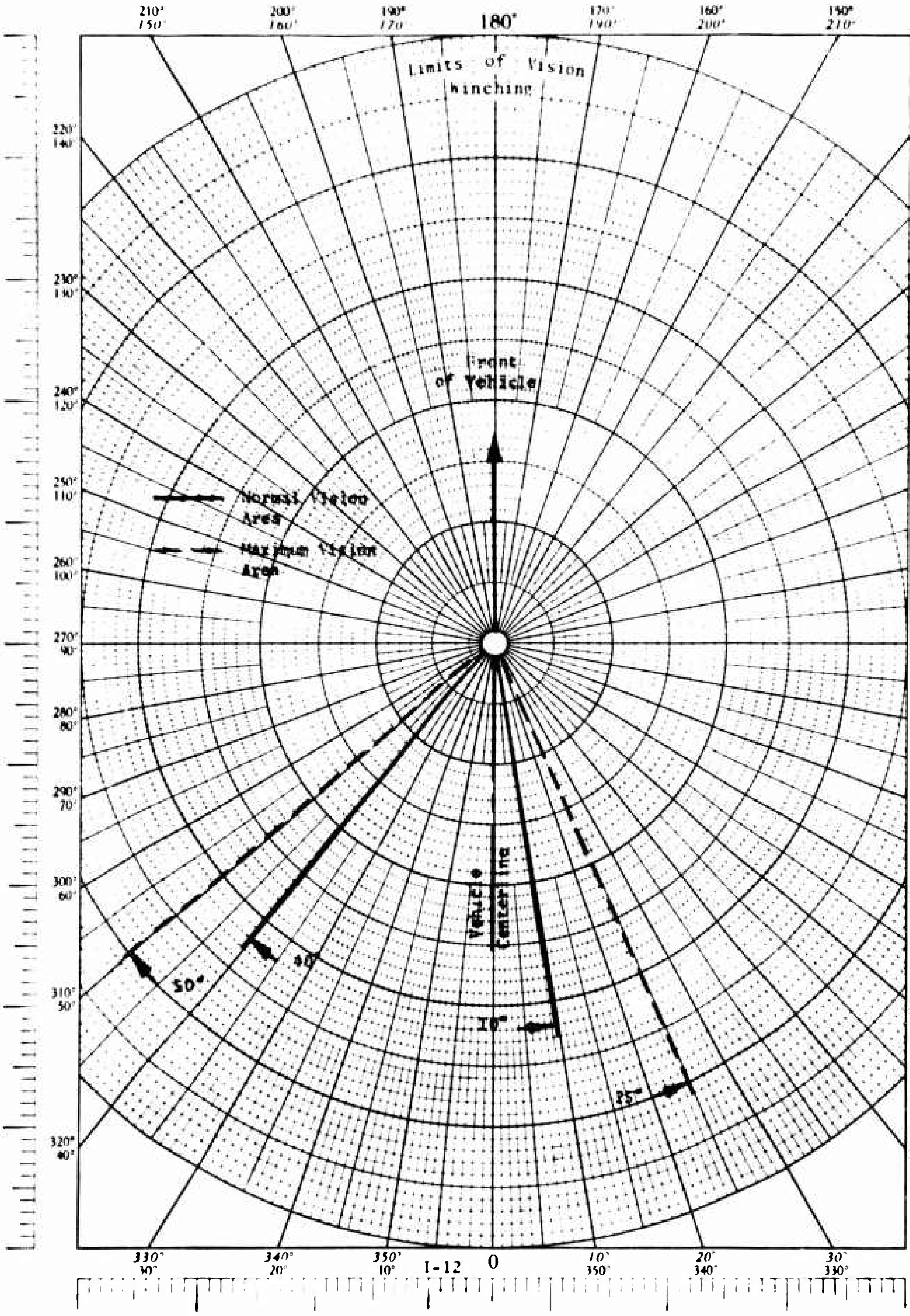




Horizontal Limits of Winch Operation with Ramp Down and Ramp Up and Personnel Access Door Open



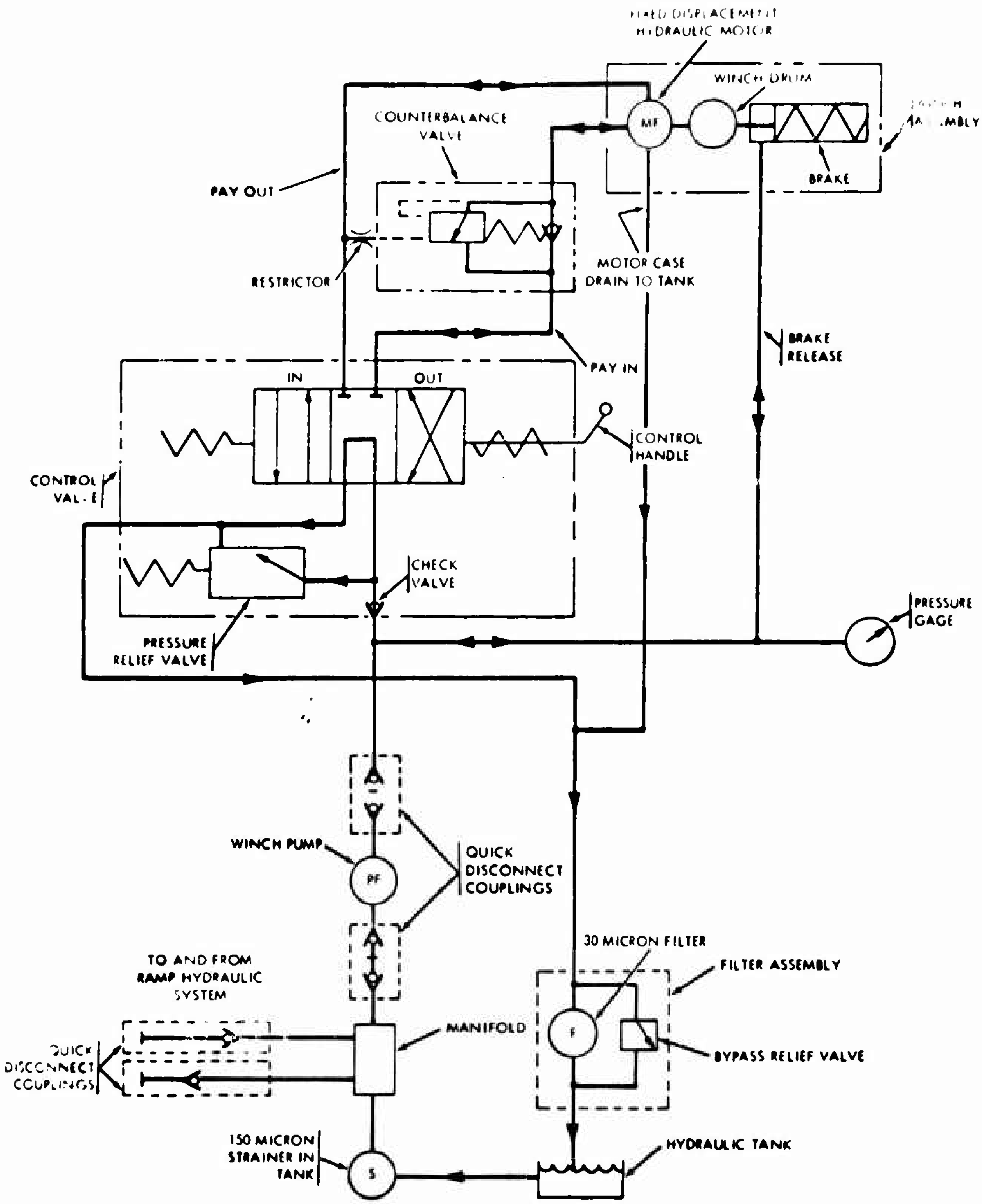
Vertical Limits of Winch Operation with Ramp Down and
with Ramp Up and Personnel Access Door Open



180°
Limits of Vision
Winching
Front
of Vehicle
Normal Vision
Area
Maximum Vision
Area
Vehicle
Centerline
50°
40°
10°
25°
0

Crane Angular Displacement and Reach Beyond Side of M113 Recovery Vehicle and XM806E1

Relative to the Horizontal, deg	Reach beyond Side of Vehicle, inches
Short Boom (45-Inch Boom Length)	
-80.5	2
-69	10
-60	16
-49.5	22
-36	28
0	32-3/4 (max)
+19	28
+31.5	22-5/8
Extended Boom (60-Inch Boom Length)	
-80.5	3-13/16
-74.5	10
-68	16
-61.5	22
-54	28
-45.5	34
-35.5	40
-20	46
0	47-3/4 (max)
+ 8	46
+22.5	40
+31.5	34-7/8



Winch Hydraulic System Schematic

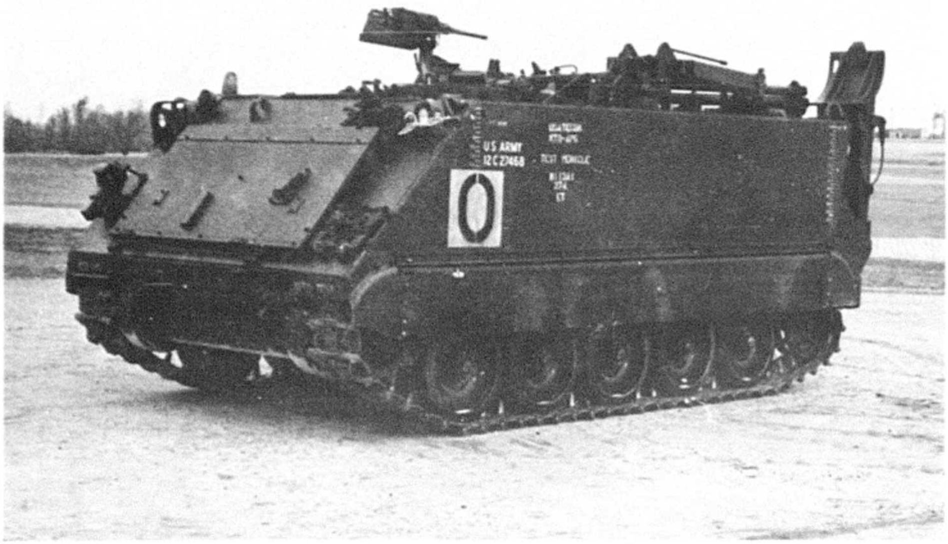


Figure II-1: Left Front View of XM806E1 Recovery Vehicle.

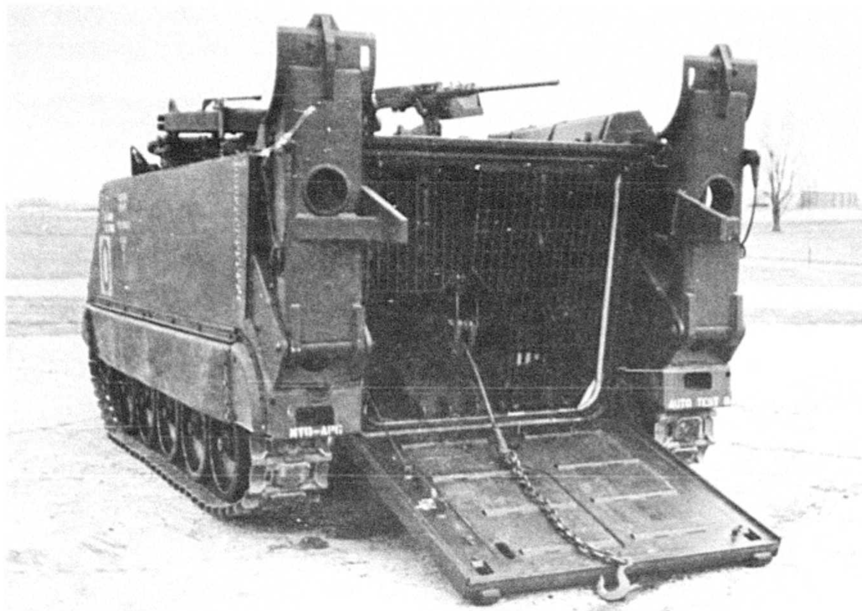


Figure II-2: Left Rear View of XM806E1 Recovery Vehicle.

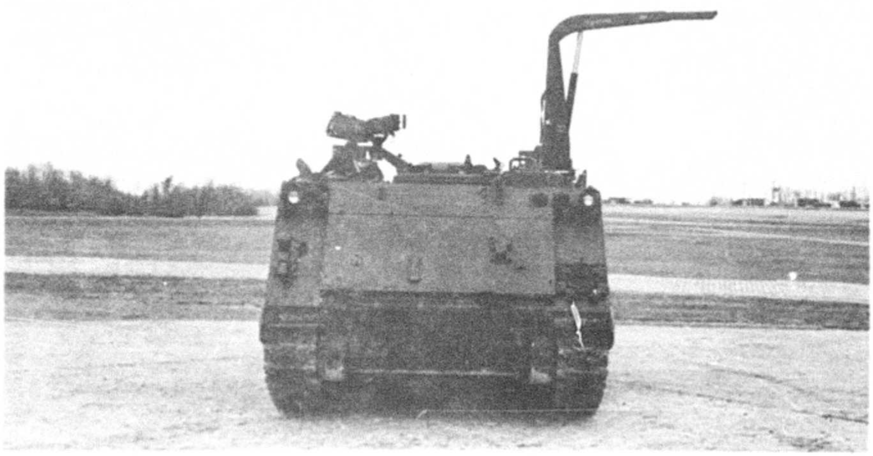


Figure II-3: Front View of XM806E1 with Crane Boom in Fully Extended Position (3000-Pound Capacity).

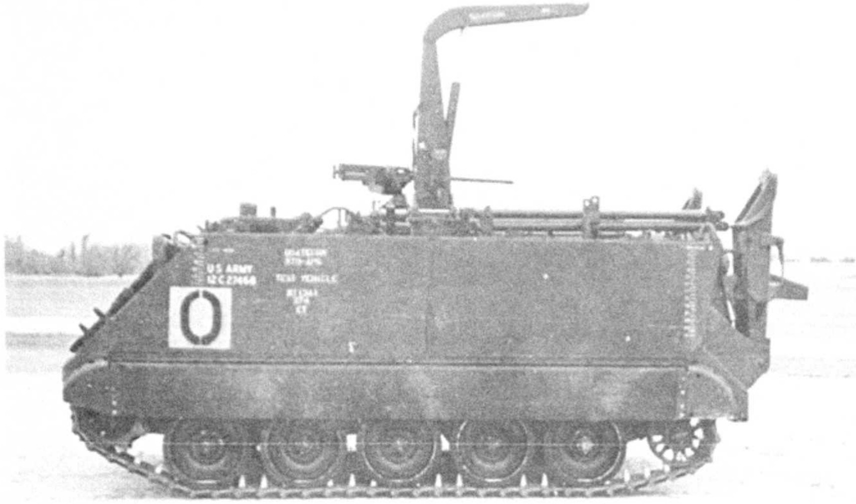


Figure II-4: Left Side View of XM806E1 with Crane Boom in Retracted Position (4000-Pound Capacity).

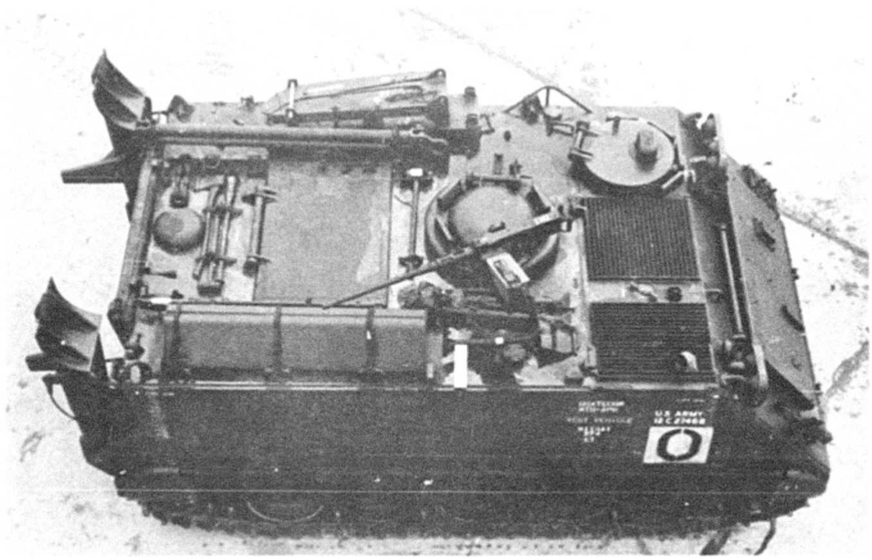


Figure II-5: Top View of XM806E1 Indicating Stowage Provisions.

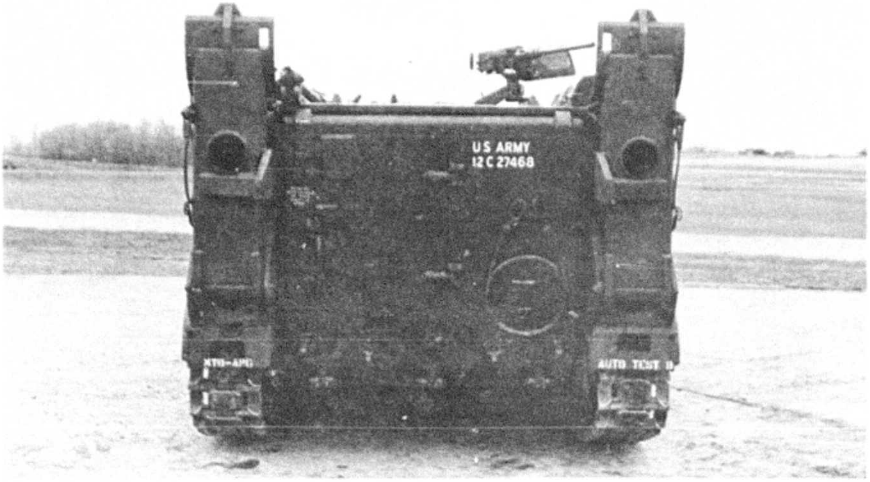


Figure II-6: Rear View of XM806E1 Recovery Vehicle.

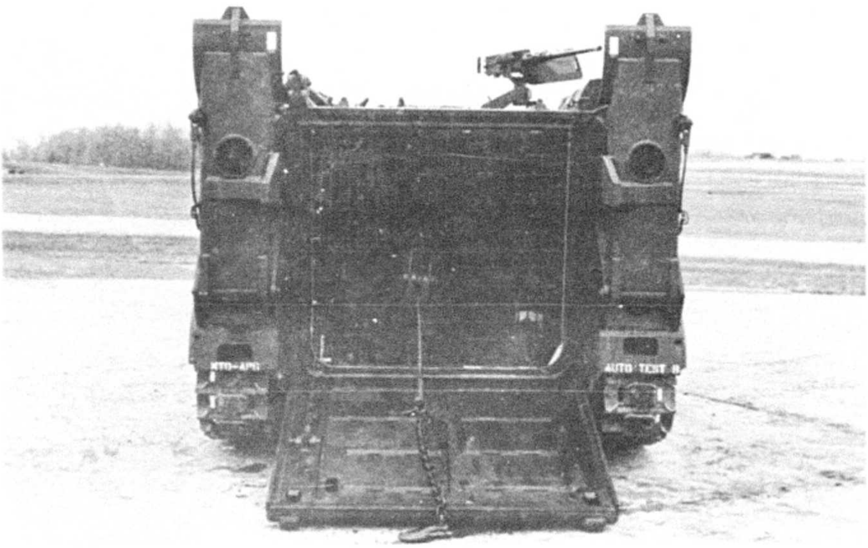


Figure II-7: Rear View of XM806E1 Showing Safety Gates in Position.

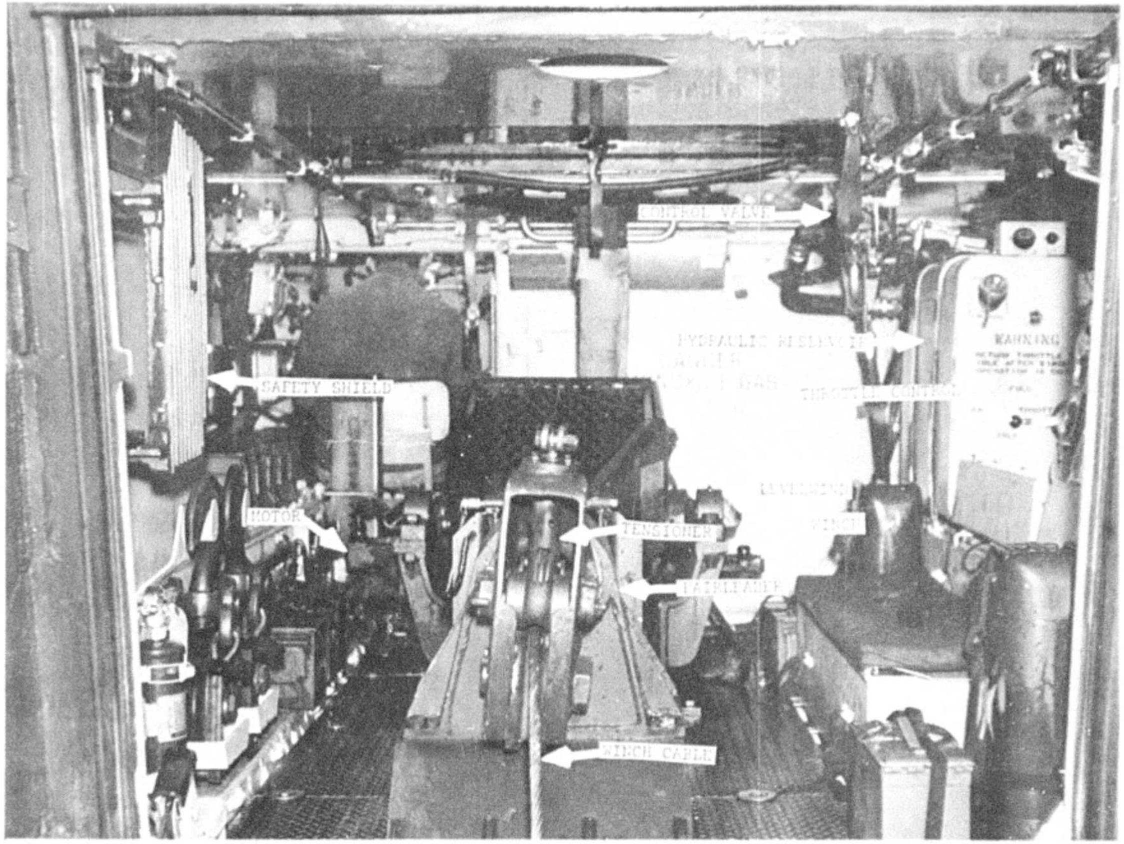


Figure II-8: Rear View of XM806E1 with Safety Gates Open.

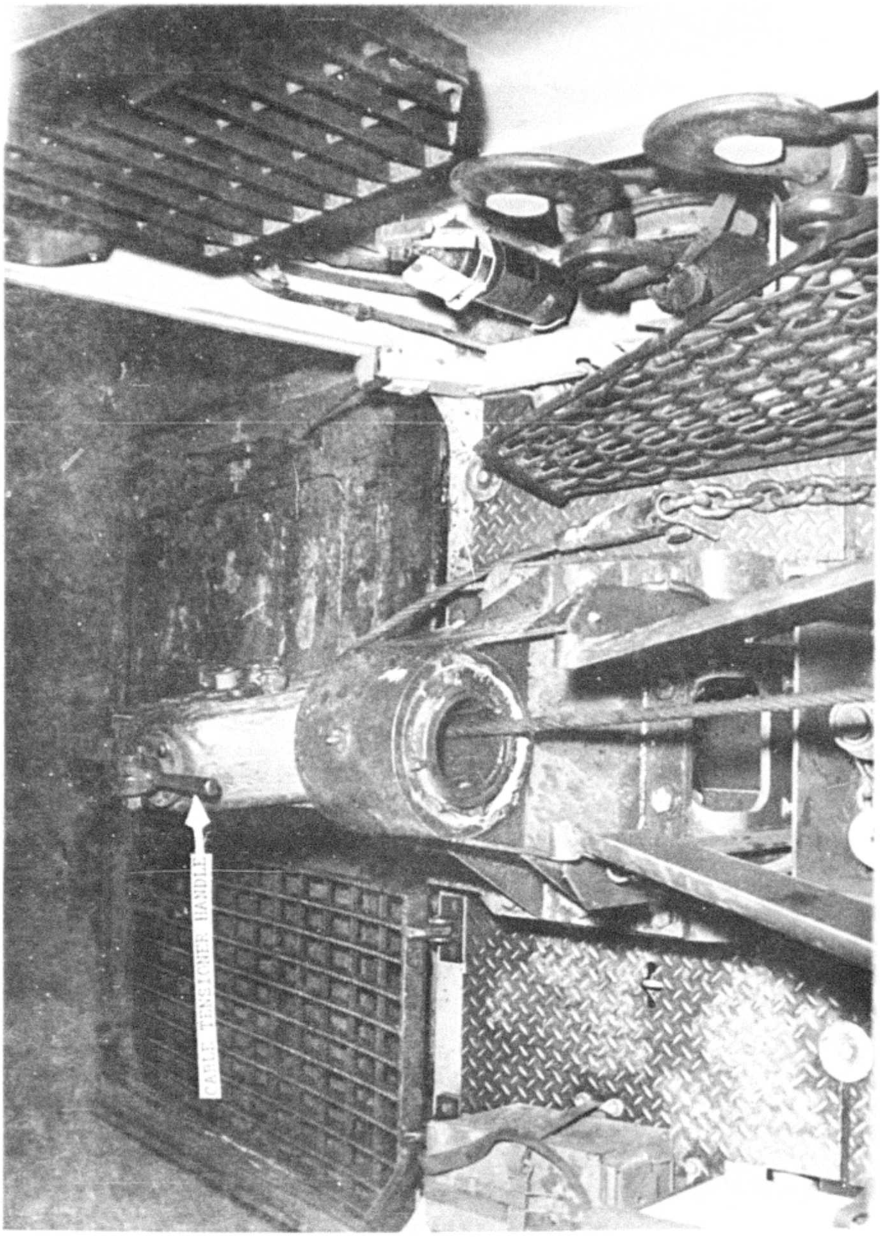


Figure II-9: Front View of Fairleader Assembly.

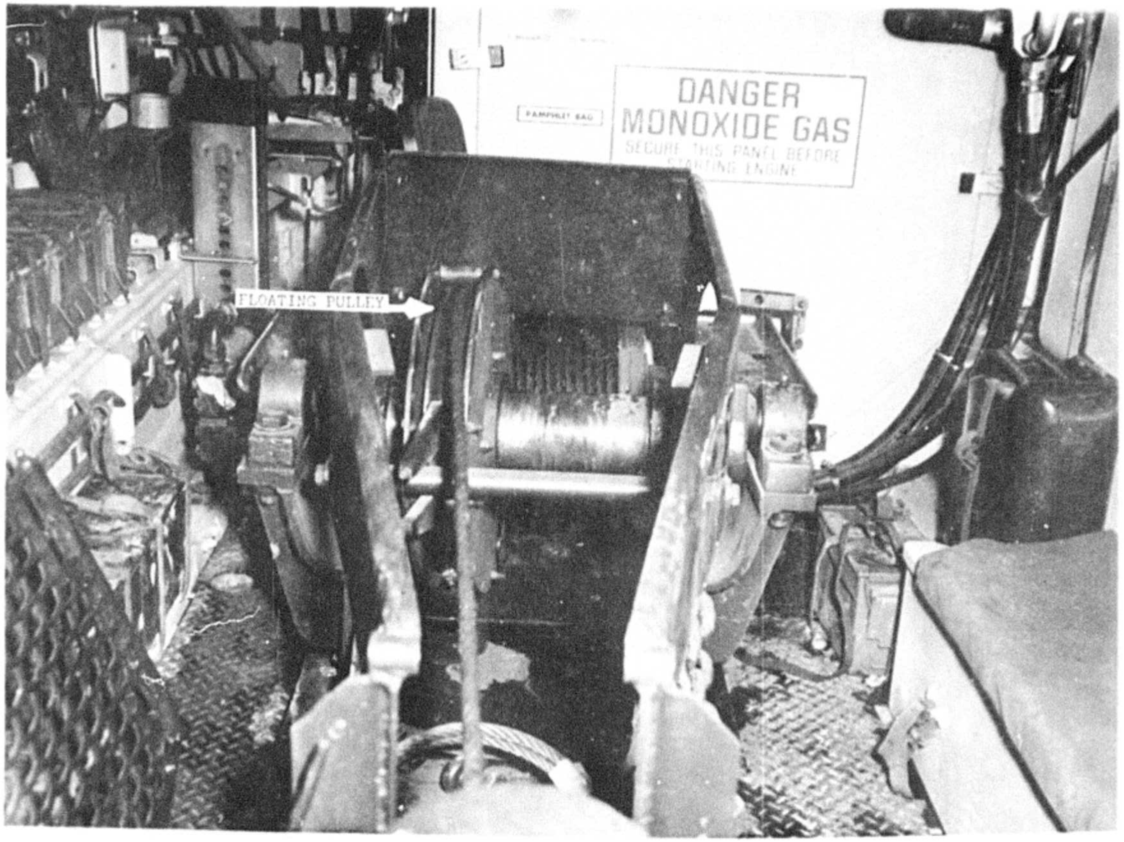


Figure II-10: Rear View of Level Wind Assembly. Protective Guard Has Been Removed for Clarity.

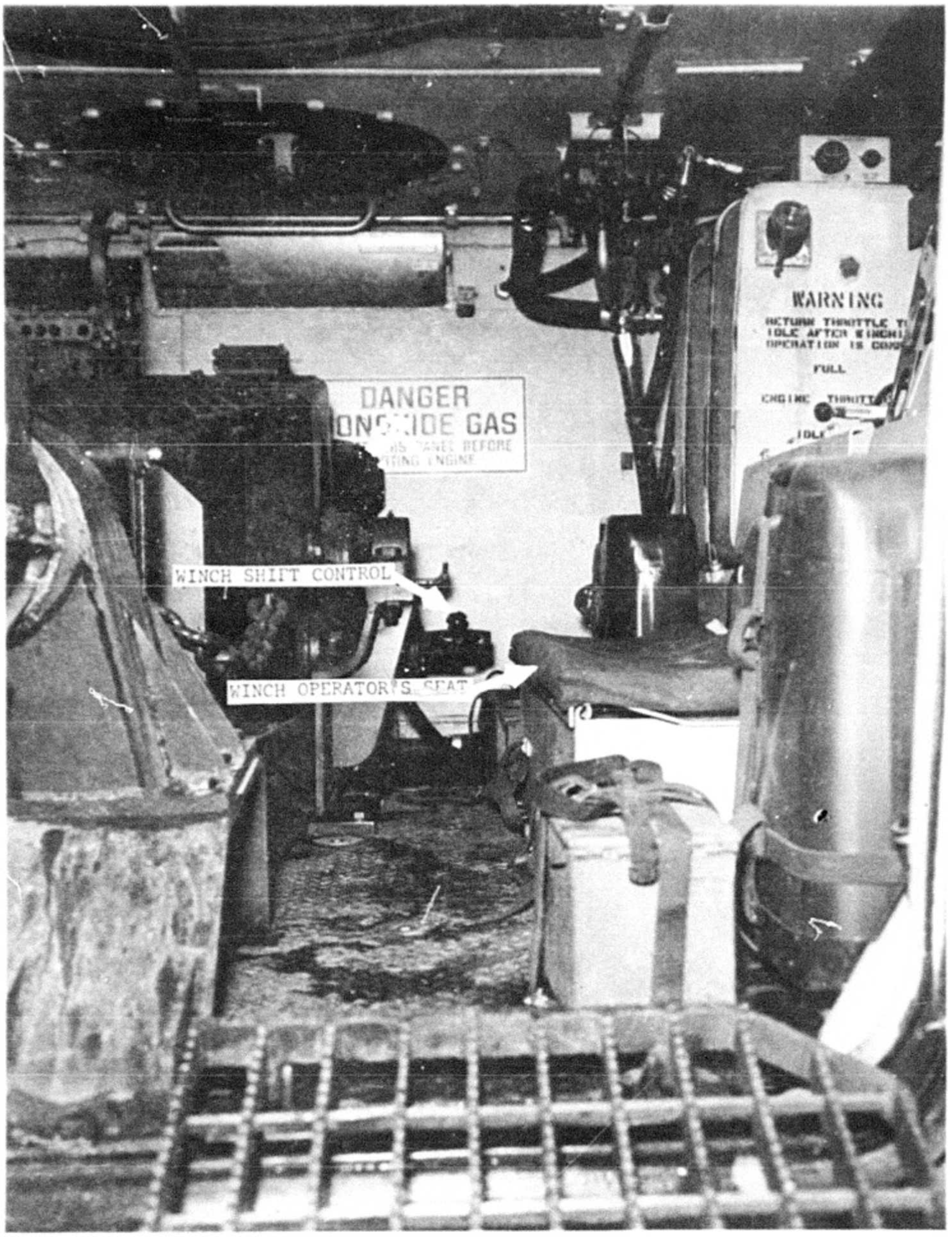


Figure II-11: Stowage Provisions Along Right Aisle.

Figure II-12: Stowage Provisions Along Left Aisle.

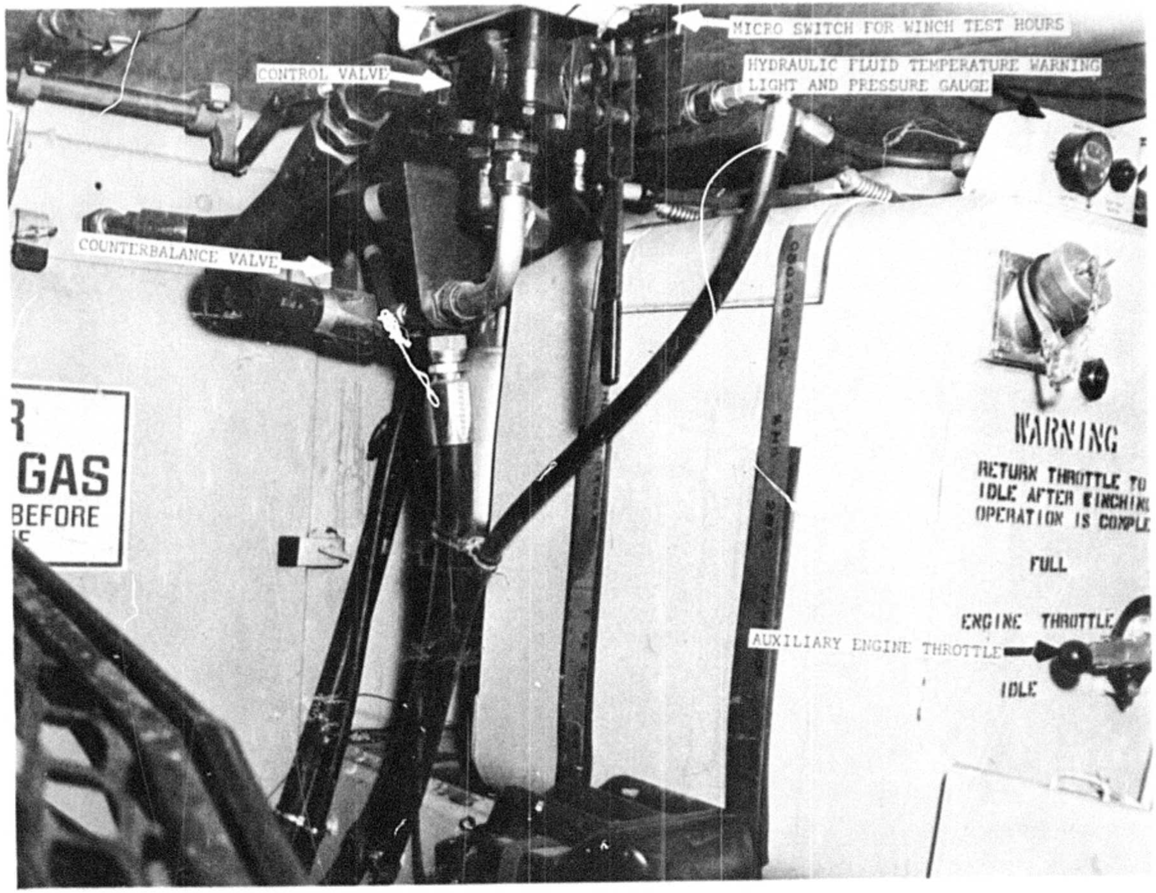


Figure II-13: Winch Hydraulic Control Valve and Reservoir.

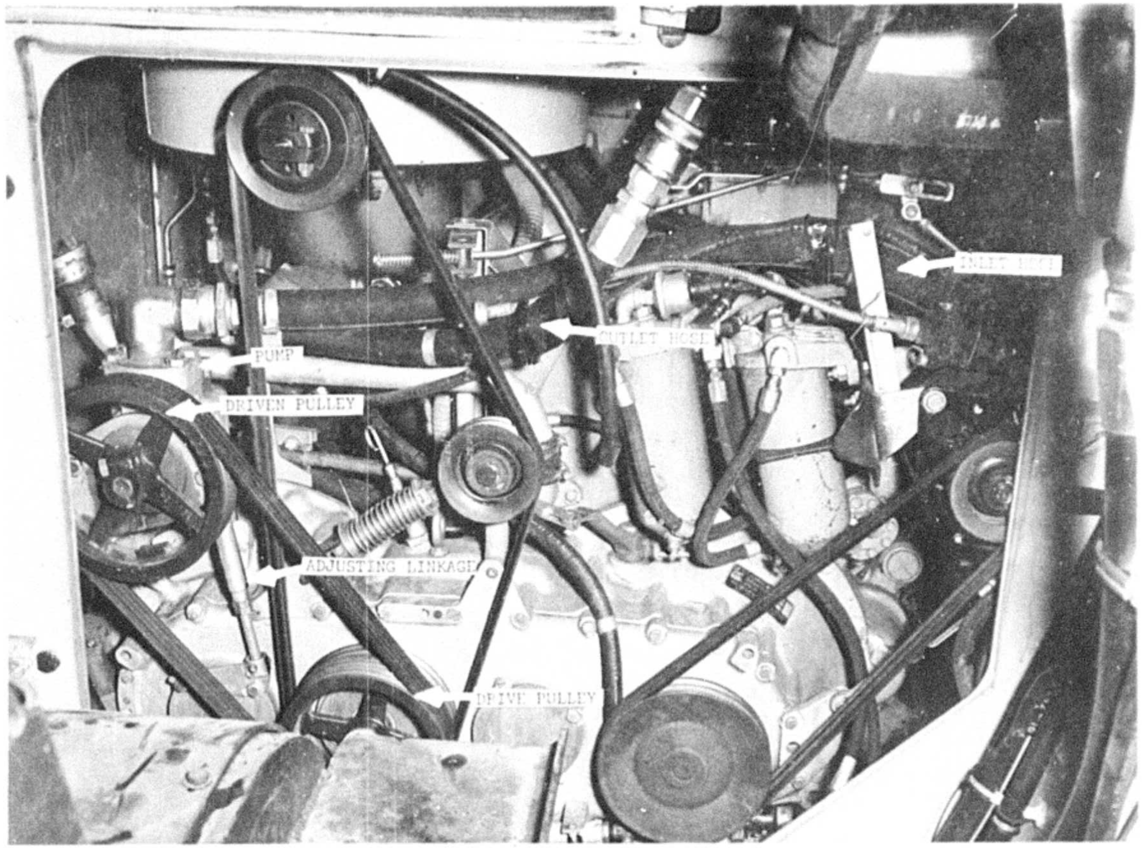


Figure II-14: Rear View of Engine Compartment.

Figure II-15: Arrow Indicates Hydraulic Fluid Temperature Gage As Installed. Although Not Clearly Shown, the Gage Is Mounted on a Slanted Boss Which Points the Gage Approximately 45 Degrees Horizontally Inboard.

Figure II-16: Amphibious Characteristics of XM806E1 Were Similar to Standard M113A1.

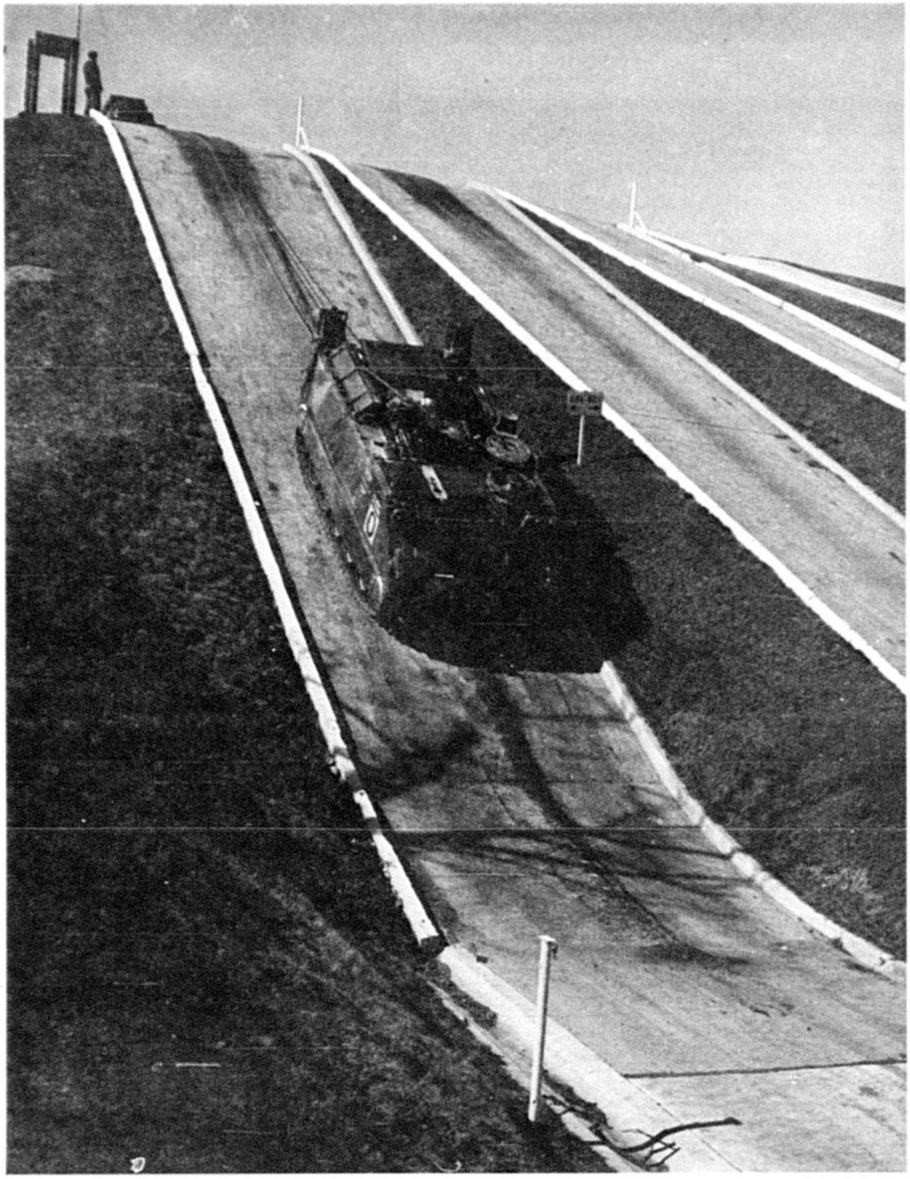


Figure II-17: Test Vehicle Successfully Winched Itself Up the 60% Slope Using a Two Part Line Pull.

Figure II-18: XM806E1 Recovering Disabled M113A1 From Munson Swamp Area.

Figure II-19: Typical Swamp Recovery Operation Where Line Pulls Were Recorded From 9,000 to 20,000 Pounds.

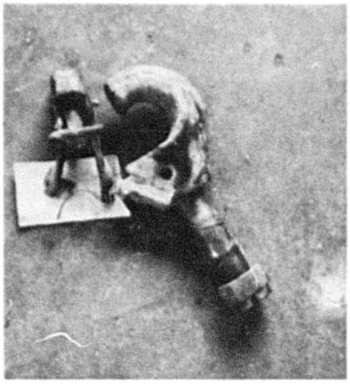


Figure II-20: Typical Failure of Standard M113A1 Tow Pintle.

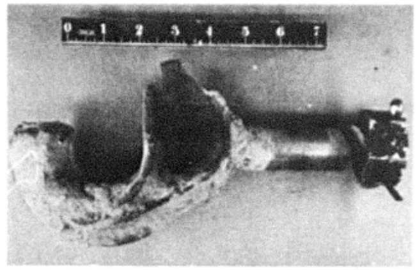


Figure II-21: Towing Pintle That Failed After Towing An M113A1 For 59 Miles Across Level Cross-Country Terrain.

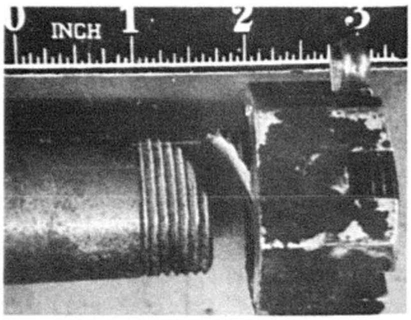


Figure II-22: Side View and Close-Up of Failed Area. Shaft Appears to Indicate a Shear Failure, However, Failed Surface Indicated a Tensile Failure. Angled Break Probable Occurred When the Vehicle Negotiated A Bump on the Cross-Country Course.

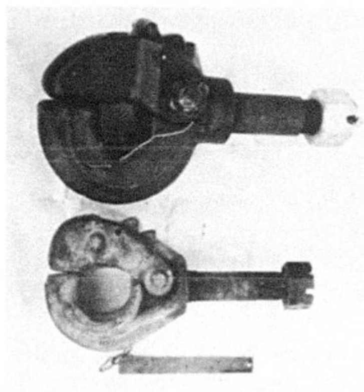
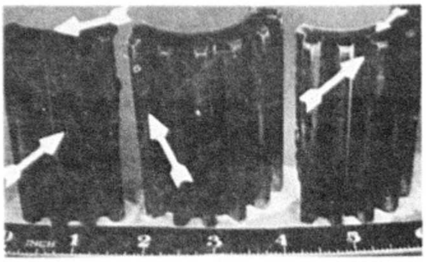
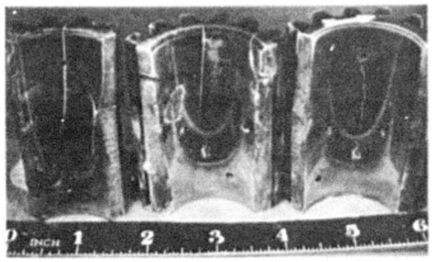


Figure II-23: Standard M113A1 Tow Pintle Is Shown Below Larger Pintle (M548 Type) That Was Satisfactory for 1024 Miles of Towing Operations. Six Inch Ruler Indicates Relative Size Difference.





Left: Internal View.

Right: External View.

Figure II-24: Internal and External Views of Winch Stage Three Carrier Housing Planetary Gear That Failed After 59.8 Winch Hours. Arrows Indicate Cracks That May Either Have Resulted from the Impact Loading At the Time of Failure or from Material Weakness.

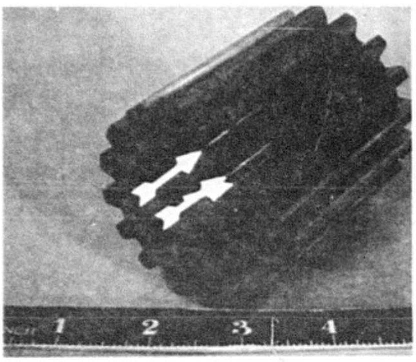


Figure II-25: Spur Gear from the Same Housing As the Failed Gear Shown in Figure II-24. Arrows Point to Cracks Along Tooth Roots.

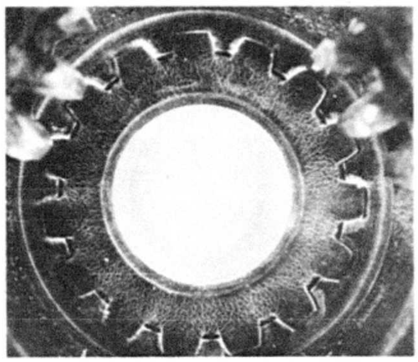


Figure II-26: New Second Stage Sun Gear As Received from the Manufacturer. The Assembly Was Intended for Use As A Replacement Component. Surface Cracks Probably Resulted from Heat Checking during Grinding Operations.

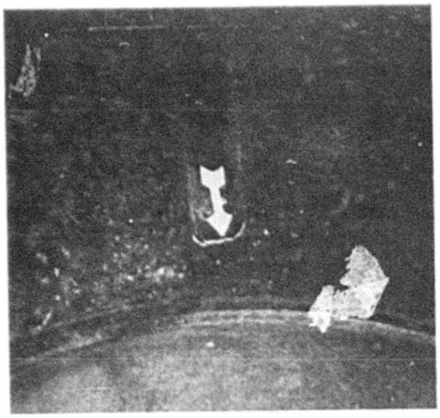


Figure II-27(a).

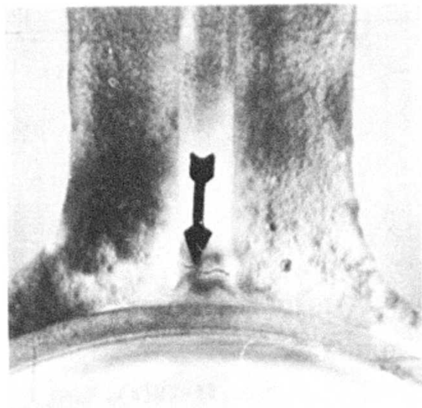


Figure II-27(b).

Figures II-27(a) and II-27(b): Arrows Point to Typical Cracks Found in Level Wind Floating Pulley Spoke Support Ribs. Figure II-27(a) Shows Pulley for the XM806E1 Vehicles and Figure II-27(b) Shows the Pulley for the M113 Recovery Vehicle.

Figure II-28(a).

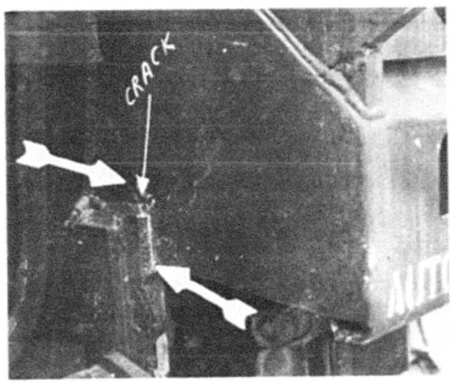


Figure II-28(b).

Figures II-28(a) and II-28(b): Figure II-28(a) Shows Crack Found in Right Fender of the XM806E1 during Final Inspection. The Crack Has Been Accented with Dye. Figure II-28(b) Shows Right Fender After the Final Inspection of M113 Recovery Vehicle.

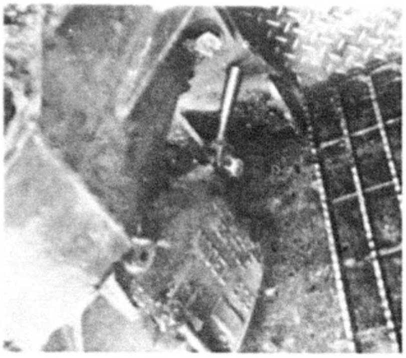


Figure II-29(a).

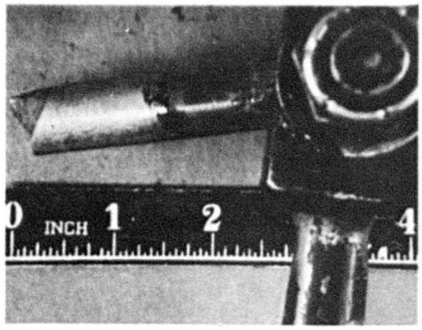


Figure II-29(b).

Figures II-29(a) and II-29(b). Figure II-29(a) Indicates How Fairleader Had Rotated Where Fairleader Mount Has Interfered with Tensioner Handle. Torsion Failure of Tensioner Eyebolt Is Shown In Figure II-29(b) When Handle Struck Mount.

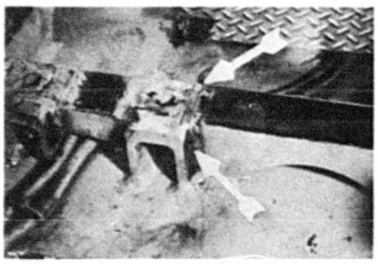


Figure II-30(a).

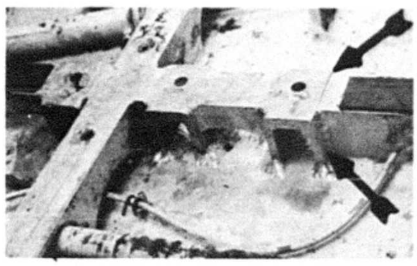


Figure II-30(b).

Figures II-30(a) and II-30(b). In Figure II-30(a) Arrows Indicate the Length of the Left Front Hull Channel Mount Crack Found After the XM806E1 Test. Figure II-30(b) Shows Similiarity in Defect Found After M113 Recovery Vehicle Test.

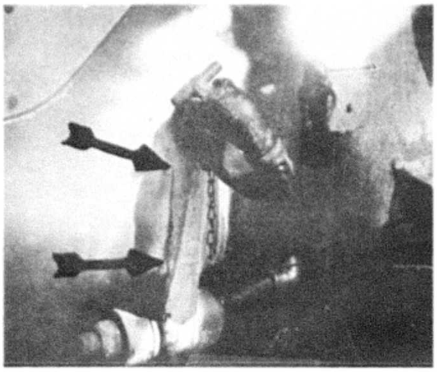


Figure II-31: Arrows Indicate Length of Crack Propagating Along Left Weld of Ramp Center Hinge Support Rib After 972 Miles of Towing. A Dye Penetrant Was Used to Accent Crack for Photographic Affect. The Actual Crack Is A Hairline and Not of the Width Indicated by the Dye.

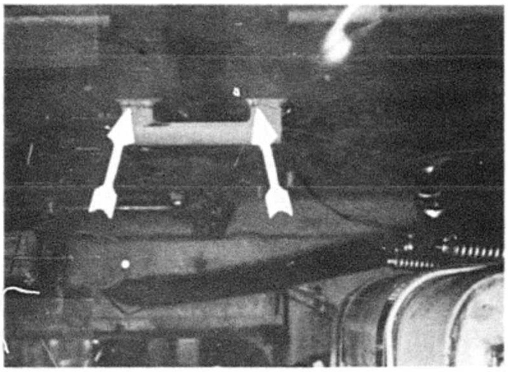


Figure II-32: Arrows Indicate Cracks Found in the Welds Securing the Control Valve Bracket to the Hull Deck after 88.8 Winch Hours. The Bracket Is Identical In Design Along the Forward Edge. Cracks Were not Found in the Forward Welds.

Specific requirements have not been established for the XM806E1, however for a general evaluation the M113A1 military specification (1), and the XM806E1 ATPD (2) have been used to evaluate the subject vehicle.

Requirement	Source Par.	Findings	Reported in Par. No.
1. Workmanship and Reliability. The workmanship shall be of a quality to assure that the vehicle and components thereof are free from any defects that compromise, limit, or reduce the vehicle or component capabilities herein expressed resulting from improper manufacturing or assembly practices. Vehicles made in accordance with this specification shall be subjected to examinations and tests to prove vehicle capabilities do perform in accordance with the following:	(1) 3.2.1 (2) 3.2.1	Automotive components did not require replacement during 4000 miles of operation, however, the winch required major overhaul prior to test completion of 100 hours.	2.19
a) Vehicle shall require only organizational maintenance (first and second echelon) during 2000 miles of normal operation.			
b) Vehicle shall require no replacement or major overhaul of any major automotive component during 4000 miles of normal operation.			
c) Complete track assemblies, or individual shoes, shall require no replacement during 3000 miles of normal operation.			

Requirement	Source Par.	Findings	Reported in Par. No.
2. Sealer. The sealer used shall prevent the entrance of water in excess of 1 quart per minute into the hull when vehicle is fording streams or rivers and when operating amphibiously.	(1) 3.4.1.1 (2) 3.4.1.1	Satisfactory.	2.10
3. Seals. When fording or operating amphibiously, the seals shall be capable of preventing the entrance of foreign matter into the bearings, which are exposed to contamination during these operations. All bearing seals shall prevent the leaking of lubricants from the bearings.	(1) 3.4.1.2 (2) 3.4.1.2	Satisfactory.	2.10
4. Winterization Equipment. Provisions shall be made for installation of winterization equipment, including personnel heaters. When specified and installed, this winterization equipment shall assure engine starting and operation under arctic conditions in ambient temperatures of -25°F to -65°F.	(1) 3.4.2 (2) 3.4.2	Untested. Installation difficulties of the standard M113A1 personnel heater are anticipated because of interference with the winch hydraulic system.	
5. Engine. Engine shall conform to DAPD-2[illegible]6. When installed in vehicle, engine shall operate throughout all gear ranges, without evidencing any leaking of the cooling system, lubricants, and fuel.	(1) 3.4.3 (2) 3.4.3	Satisfactory.	2.19

Requirement	Source Par.	Findings	Reported in Par. No.
6. Engine Air-Induction System. The air-induction system, as installed, shall prevent entrance of all foreign matter.	(1) 3.4.3.1 (2) 3.4.3.1	Satisfactory. No problems occurred throughout testing.	2.19
7. Exhaust System. The concentration of carbon monoxide in the crew compartment shall not exceed 0.01%. The exhaust system, as installed, shall be gastight and leakproof.	(1) 3.4.4 (2) 3.4.4	Untested. Exhaust system identical to standard M113A1.	
8. Fuel System. During vehicle operation, the fuel system shall maintain a continuous supply of fuel to the engine when ascending and descending 60% grades in forward and reverse gear, and when vehicle is being operated on 30% side slopes, with each side of vehicle up slope.	(1) 3.4.5 (2) 3.4.5	Satisfactory.	2.8, 2.9
9. Fuel Tanks. Provisions shall be made to assure the internal cleanliness of the fuel tanks prior to initial fueling of vehicle. The fuel tanks shall be capable of receiving 50 gallons of fuel per minute.	(1) 3.4.5.1 (2) 3.4.5.1	Untested. Fuel tank configuration identical to standard M113A1.	
10. Fuel and Hydraulic Lines. Fuel and hydraulic lines and connections shall be internally clean prior to initial fueling of vehicle. All fuel and hydraulic lines connections and tanks shall be free from leakage.	(1) 3.4.5.2 (2) 3.4.5.2	Unsatisfactory. Counterbalance valve and crane leaked hydraulic fluid.	2.19

Requirement	Source Par.	Findings	Reported in Par. No.
11. Rack Linkage. With rack linkage installed in accordance with applicable drawings, and with the accelerator pushed against the stop, the rack shall be at full-open position.	(1) 3.4.5.4 (2) 3.4.5.4	Untested. No problems were encountered during durability test.	
12. Generating System Voltage (Alternator). The regulator shall be adjusted, after no less than 20 minutes of operation, with an electrical load that shall cause a 14-volt drop (to warm up the system) across the alternator field. The alternator shall be run at 4000 ± 100 rpm with an output of 50 ± 5 amperes and the voltage regulator rheostat adjusted so that the system voltage will be 28. The final voltage, without external load, shall be within the regulation limits of 28 ± 0.5.	(1) 3.4.6.1 (2) 3.4.6.1	Untested. Identical electrical generating system as the standard M113A1.	
13. Lights. The internal and external lights as specified on applicable drawings shall operate throughout all vehicle operating conditions. All electrical contacts and connections shall maintain positive contact under all vehicle operating conditions.	(1) 3.4.6.2 (2) 3.4.6.2	Satisfactory.	Satisfactory operation during durability testing, par. 2.19.

Requirement	Source Par.	Findings	Reported in Par. No.
14. Heater. The heater shall be capable of starting and operating satisfactorily on 18.5 volts dc.	(1) 3.4.6.3 (2) 3.4.6.3	Untested. Standard M113A1 personnel heater difficulties anticipated.	
15. Communication and Electrical Circuits. The communication and electrical circuits shall be capable of maintaining continuity from end to end, without any shorts from one pin to the other, and from each pin to the connector shell.	(1) 3.4.6 (2) 3.4.6	Untested. Communication equipment not installed in test vehicle.	Electrical system operated satisfactorily during durability testing.
16. Trim Vane. The trim vane shall retain its extended position when vehicle is being operated amphibiously.	(1) 3.4.7 (2) 3.4.7	Satisfactory.	Trim vane remained extended during amphibious operations, par. 2.10.
17. Ramp System. The ramp system shall be internally clean and all connections shall be tight prior to initial filling of the system. Ramp raising time from the fully lowered position to closed position shall be not more than 18 seconds at a maximum of 1200 rpm of the engine.	(1) 3.4.8 (2) 3.4.8	Untested. Similar ramp system as installed in a standard M113A1.	
18. Hatches. All hatches when closed shall prevent the entrance of water into vehicle under all conditions of vehicle operation.	(1) 3.4.9 (2) 3.4.9	Satisfactory.	No leakage during durability testing, par. 2.19.

Requirement	Source Par.	Findings	Reported in Par. No.
19. Controls. All electrical, mechanical, and hydraulic controls shall operate without malfunction throughout all ranges of operation under all vehicle operating conditions.	(1) 3.4.10 (2) 3.4.10	Unsatisfactory. Misalignment between shift rod spool and motor coupling prevented complete engagement of winch shift control handle.	2.19
20. Adjustment Mechanisms. All adjustment mechanisms shall function properly, and maintain adjustment settings during all vehicle operating conditions.	(1) 3.4.11 (2) 3.4.11	Satisfactory.	All adjustment mechanisms maintained adjustment during durability test, par. 2.19.
21. Stowed Equipment. All interior and exterior on-vehicle-equipment (OVE) items shall be stowed (combat loaded) on the vehicle in the spaces provided, to assure that items will not interfere with the operation of vehicle and components in any manner.	(1) 3.4.12 (2) 3.4.12	Satisfactory.	2.3
22. Cupola. With the vehicle level, the installed cupola without gun and ammunition shall rotate (after breakway) without binding under an applied torque of 15 pound feet maximum with commander's hatch closed.	(1) 3.4.14 (2) 3.4.14	Untested. Cupola identical to standard M113A1.	

Requirement	Source Par.	Findings	Reported in Par. No.
23. Vision Devices. Vision device receptacles incorporated in the vehicle shall accept the Government supplied visions devices without binding or interference.	(1) 3.4.15 (2) 3.4.15	Satisfactory.	2.3
24. Condition After Break-In Run. After completion of the break-in run, there shall be no indications of damaged components, maladjustment or loss or original adjustment that may cause faulty vehicle operation subsequent to Government acceptance.	(1) 3.5.5 (2) 3.5.5	Satisfactory.	2.4
25. Environmental. The vehicle shall operate in ambient air temperature of +115°F to -25°F, and with special equipment installed, at temperature ranges of -25°F to -65°F. The complete vehicle when in storage shall withstand climatic extremes as specified in MIL-STD-210, without deterioration that may cause failure of any component part of the vehicle.	(1) 3.6.1 (2) 3.6.1	Untested. Possible installation difficulties of standard M113A1 personnel heater.	
26. Engine Cooling. With the vehicle operating in ambient temperatures up to +115°F, the engine cooling system shall maintain engine coolant at not more than +230°F, measured at a point in the engine outlet to radiator.	(1) 3.6.2.1 (2) 3.6.2.1	Untested. Cooling system identical to standard M113A1.	

Requirement	Source Par.	Findings	Reported in Par. No.
27. Transmission Lubricant Cooling. With the vehicle operating in ambient temperature up to +115°F, the transmission lubricant cooling system shall maintain lubricant temperature at no more than +300°F measured out of transmission into cooler, except at torque converter speed ratios less than 4/10.	(1) 3.6.2.2 (2) 3.6.2.2	Untested. Transmission cooling system identical to standard M113A1.	
28. Differential Oil Cooler. With the vehicle operating in ambient temperature up to +115°F, the differential lubricant cooler shall maintain lubricant temperature below +300°F, measured out of differential into cooler.	(1) 3.6.2.3 (2) 3.6.2.3	Untested. Differential oil cooler identical to standard M113A1.	
29. Bilge Pumps. The bilge pumps, installed in accordance with applicable drawings, shall remove water from the vehicle at a minimum rate of 44 gpm each, with a discharge head of 4-1/2 feet and with pump motor operating on 27.5 volts impressed at the motor.	(1) 3.6.3 (2) 3.6.3	Untested. Water from rear bilge pump outlet interfers with side spade.	2.10
30. Speeds and Vehicle Control. The vehicle shall sustain speeds up to 32 mph, and shall attain a speed of 40 mph after 400-mile operation without damage to power plant and suspension system. Performance shall	(1) 3.6.4 (2) 3.6.4	Satisfactory.	2.14

Requirement	Source Par.	Findings	Reported in Par. No.
be demonstrated on smooth, relatively level, hard-surface road. With vehicle traveling between 15 mph and maximum speed, the drift shall not exceed 3 feet in 100 feet.			
31. Acceleration. With the vehicle at a standstill position and the transmission in 1-2-3 range, engine at idle speed, the vehicle shall accelerate from 0 to 20 mph in not more than 11 seconds on smooth, relatively level, hard-surfaced road.	(1) 3.6.5 (2) 3.6.5	Satisfactory.	2.15
32. Engine Starting on Grades and Side Slopes. With vehicle standing on a 60% grade for not less than 2 minutes with engine operating under no load between 750 and 1000 rpm, the engine shall be stopped for not less than 2 minutes. The engine shall restart in not more than 1 minute when vehicle is headed up and headed down grade respectively. A similar engine starting test shall be conducted on 30% side slopes with right and left side of vehicle up slope.	(1) 3.6.6 (2) 3.6.6	Satisfactory.	2.8, 2.9

Requirement	Source Par.	Findings	Reported in Par. No.
33. Stopping and Vehicle Control. Vehicle shall stop within a distance of 40 feet from point of service brake application when traveling at speed of 20 mph, on smooth, relatively level, hard-surfaced roads free of loose material, and drift not to exceed 3 feet in stopping distance. During stopping, the vehicle being under driver individual control steering action is permitted.	(1) 3.6.7.1 (2) 3.6.7.1	Satisfactory.	2.16
34. Holding. With brakes locked for parking, and with transmission in neutral, the vehicle shall be held stationary when parked on a 60% longitudinal grade. For this operation, vehicle shall be combat loaded, or with a simulated load of equal weight.	(1) 3.6.7.2 (2) 3.6.7.2	Satisfactory.	2.8, 2.16
35. Turning. Vehicle, on smooth, relatively level, hard-surfaced roads or track, with differential steer, shall make continuous full 360° turns to right and to left, with rear point of outer edge of vehicle at all times in contact with or within a 50-foot diameter circle. When in pivot steer, the vehicle shall pivot within a 28-foot diameter circle. The applied effort to the steering lever shall not exceed 100 pounds to pivot vehicles.	(1) 3.6.8 (2) 3.6.8	Satisfactory.	2.13

Requirement	Source Par.	Findings	Reported in Par. No.
36. Leakage. During shallow water crossings and amphibious operation the leakage of water into the hull shall be not more than 1 quart per minute.	(1) 3.6.9.1 (2) 3.6.9.1	Satisfactory.	2.10
37. Shallow Water Crossing. Vehicle shall ford shallow, hard-bottom, salt or fresh water up to the depth required to float vehicle.	(1) 3.6.9.2 (2) 3.6.9.2	Satisfactory.	2.10
38. Amphibious Operation. Vehicle, launched amphibiously, combat loaded or with a simulated load of equal weight, shall negotiate water of unlimited depth with height of waves not exceeding 1 foot. When afloat, in calm water, not less than 28 feet in depth, the vehicle shall attain a maximum speed of not less than 3 mph. The vehicle shall be capable of operating within a 30-foot corridor when crossing calm, open water.	(1) 3.6.9.3 (2) 3.6.9.3	Satisfactory.	2.10
39. Trench Crossing. Vehicle shall cross trenches up to 36 inches or more in depth and up to 60 inches in width, without damage to vehicle.	(1) 3.6.10 (2) 3.6.10	Satisfactory.	2.7

Requirement	Source Par.	Findings	Reported in Par. No.
40. Vertical Obstacles. Vehicle operating at low speeds in forward gear shall cross over vertical obstacles up to 24 inches in height, and in reverse gear obstacles up to 14 inches in height, without damage to vehicle.	(1) 3.6.11 (2) 3.6.11	Satisfactory.	2.7
41. Climbing. Vehicle shall ascend 60% grades in forward and reverse gear from a stand-still position on the grade without stalling or damage to power plant.	(1) 3.6.12 (2) 3.6.12	Satisfactory.	2.8
42. Winch Hydraulic System. The hydraulic system shall operate with smooth positive control of the winch throughout the entire operating range, under all operating conditions specified herein. Using oil conforming to MIL-H-6083, the winch hydraulic system shall operate in ambient air temperature up to +115°F. With initial hydraulic oil temperature up to +125°F in the reservoir, the hydraulic oil shall remain below +170°F in the reservoir, for 300 feet of cable pay-in at full load using winch in low gear.	(2) 3.6.13	Satisfactory.	2.17

Requirement	Source Par.	Findings	Reported in Par. No.
43. Instrumentation and Controls. The hydraulic system instruments shall include hydraulic fluid pressure and temperature gages so located to assure winch operator clear view of all gages. For normal vehicle operation, the idle speed and control of engine shall not be affected with the remote throttle in idle (down) position. An engine speed of 2700 rpm ± 25 rpm shall be obtained under no load condition with remote throttle in up position. All manually operated controls shall be located within easy reach of operator. Warning light shall indicate oil temperature of +165 ± 10°F.	(2) 3.6.13.1	Satisfactory.	2.17
44. Winch. The winch, conforming to 11647128, a detail of 8736888, shall perform as specified below:	(2) 3.6.13.2	Satisfactory.	2.17

Winch Operation

Gear	Layer in Drum	Rated Load, lb	Line Speed, fpm
Low	1	20000 ± 1000	20 $^{+4}_{-2}$
High	1	4500 ± 500	75 $^{+10}_{-5}$

Requirement	Source Par.	Findings	Reported in Par. No.
45. Hydraulic Pump and Control Valves. The hydraulic pump drive belt tension shall be in accordance with 11647367, a detail of EPL 8736888. The hydraulic control valve shall be adjusted to provide a relief pressure of 1625 ± 25 psi. The rotation of winch shall be controlled by hand operation of control valve for cable pay-in and pay-out. The control valve shall assure smooth control of speed for both loaded and unloaded cable. The counterbalance valve shall assure smooth pay-out of cable under load, with winch speed selector in either low or high gear.	(2) 3.6.13.2.1	Unsatisfactory. Relief pressure setting, 1550 psi.	2.17
46. Winch Shift System. The winch shift system shall remain in either high or low gear under full load condition, and completely disconnect winch from motor in neutral.	(2) 3.6.13.2.2	Satisfactory.	2.17
47. Winch Brakes. The winch brakes shall stop and hold winch drum stationary with rated load in either low or high gear. During winch operations the brake shall release without dragging and chattering.	(2) 3.6.13.2.3	Satisfactory.	2.17

Requirement	Source Par.	Findings	Reported in Par. No.
48. Levelwind. The levelwinder operating under a tension of 300 to 20,000 pound cable load with vehicle on relatively level ground shall provide controlled spooling which shall insure that the cable spools on the drum in an evenly spaced parallel pattern from flange to flange. The first and each succeeding layer of cable on the drum shall form a spooling pattern for all succeeding layers. The spooling pattern of cable on the drum shall eliminate over-riding, undercutting of the cable, and result in a minimum amount of scrubbing and chafing of the cable.	(2) 3.6.13.2.4	Satisfactory.	2.17
49. Fairlead and Tensioner. The fairlead shall be free to rotate on its longitudinal axis, assuring that cable, under maximum pull, will follow rotating sheave through entire pattern of operation 40° to left and 50° to right of vehicle centerline with ramp open. The tensioner shall provide adequate tension on cable, when unloaded free cable is being wound tight on drum with vehicle on relatively level ground.	(2) 3.6.13.2.5	Satisfactory.	2.17

Requirement	Source Par.	Findings	Reported in Par. No.
50. Spades. With the side spades emplaced for winching operations the vehicle shall be stabilized when retrieving the maximum loads. The side spades shall operate through entire arc from latched travel (up) position to operational (down) position when reaction arm on spade strikes hull without binding or interference. The center spade shall be used when the retrieving vehicle is operating in soft earth or mud, to stabilize vehicle to maximum extent. The side and center spades shall be capable of emplacement and retraction (from and to travel position), utilizing driver and 2 crewmen, as specified below:	(2) 3.6.13.2.6	Satisfactory.	2.17

Emplacement and Retraction

Condition	Time, sec
Emplacement, both side spades	20
Retraction, both side spades	25
Emplacement, both side spades and center spade	150
Retraction, both side spades and center spade	120

Requirement	Source Par.	Findings	Reported in Par. No.
51. Safety Grills. Both rear safety grills shall rotate in intended radii and latch securely in both travel and operational positions, so that normal vehicle operational movement does not open the latches.	(2) 3.6.13.2.6	Satisfactory.	Safety grills remained in position durability testing, par. 2.19.
52. Towing. The recovery vehicle shall tow other free wheeling vehicles up to equal weight, at speeds up to one half of speeds specified in par. 3.6.4, and make minimum turns of 53 feet diameter without damage to towing bar and vehicles.	(2) 3.6.13.2.7	Satisfactory with large tow pintle.	2.13
53. Pintle. The pintle as installed on vehicle shall rotate by hand without binding and interference, and shall withstand normal operational winching and towing leads.	(2) 3.6.14.1	Standard M113A1 pintle, unsatisfactory; larger pintle tested, satisfactory.	2.19
54. Crane. The crane without load and with mast horizontal shall be manually raised from travel position to operating position in not more than 90 seconds, and manually returned to travel position in not more than 60 seconds. The vehicle combat loaded or loaded with a simulated load of equal weight shall be placed on firm relatively level ground. Mast and boom joints shall operate without binding and	(2) 3.6.15	Satisfactory.	2.18

Requirement	Source Par.	Findings	Reported in Par. No.
interference throughout the entire normal travel in the loaded and unloaded condition with vehicle on firm, relatively level ground.			
a) The crane, with boom extended to maximum reach from side of vehicle shall lift 3000 pounds clear of the ground, and raise boom to maximum height and return, with vehicle remaining stable.			
b) With the boom extended to maximum reach, the crane shall lift 3000 pounds clear of the ground and the vehicle driven forward one vehicle length, prior to returning load to ground.			
c) The crane with boom fully extended and with 3000 pounds load shall rotate from one side of vehicle to opposite side of vehicle. The crane traverse locking device shall lock and hold crane in any one of the 8 traverse positions with full load. The crane and boom shall provide means for removing and replacing the winch from installed position.			

Requirement	Source Par.	Findings	Reported in Par. No.
d) Cylinder shall support 3000 pounds with boom fully extended without oil leakage.			
e) Utility control valve shall assure smooth lowering of rated load.			
f) Auxiliary valve shall assure rapid lowering of unloaded boom.			
g) The safety device (hydraulic velocity fuze) on cylinder shall stop and hold a fully loaded boom when the auxiliary valve is open.			
55. Floodlight. The floodlight shall function properly when power is obtained from either the rear external outlet or internal outlet forward of fuel cell. Sufficient illumination shall be provided for night recovery operations 150 feet from vehicle in clear weather.	(2) 3.6.16	Untested.	
56. Electromagnetic Compatibility. Unless otherwise specified, the entire vehicle shall be radio interference suppressed in accordance to tactical vehicle requirements of Class IIIA, MIL-STD-461.	(2) 3.6.17	Untested.	

Requirement	Source Par.	Findings	Reported in Par. No.
57. Vibration and Noise. With a sound level meter (see 4.5.2.13) located 4 inches forward of the engine compartment rear bulkhead, 4 inches to the left of engine compartment left bulkhead, and 12 inches below the inside surface of the top armor plate, and with the vehicle traveling at 30 mph in a 1-2-3 gear range on a hard surfaced straight road with all hatches closed, the sound level shall not exceed the following values: a) When using the C weighting position of the sound level meter, the noise level shall be not more than 128 db. b) When using the B weighting position of the sound level meter, the noise level shall be not more than 124 db. c) When using the A weighting position of the sound level meter, the noise level shall be not more than 119 db.	(1) 3.8 (2) 3.7	Untested.	

Requirement	Source Par.	Findings	Reported in Par. No.
58. Fire Extinguisher. The fixed fire extinguisher system, when installed in accordance with applicable drawings shall be readily accessible for servicing and operation internally and externally. In ambient air temperature of +72°F, the maximum effort required to discharge the system, shall not exceed 55 pounds externally.	(1) 3.9 (2) 3.8	Untested. Fixed fire extinguisher identical to that in standard M113A1.	

APPENDIX IV - DEFICIENCIES AND SHORTCOMINGS

1. Deficiency

Deficiency	Suggested Corrective Action	Remarks
Winch stage three carrier planetary spur gear failed from material imperfections.	Enforce more rigid quality control.	Failure occurred, after 59.8 winch hours, while under steady pull. Concentration of carbides in the case and heavy stringer-type longitudinal inclusions both contributed to the failure (EPR K2-45). New replacement second stage sun gear revealed surface grinding checks (EPR K2-57).

2. Shortcomings

Shortcoming	Suggested Corrective Action	Remarks
Cable chain link failed from defective weld.	Improve quality control.	Weld only 80% effective due to gas pockets (EPR K2-32).
Winch stage one planetary spur gears cracked.		Found after magnaflux during final inspection after 100.8 winch hours. 1/2 inch long crack on each gear (EPR K2-79).
Incomplete engagement of motor coupling because of milled splines.	Lengthen splines of motor coupling to improve alignment within shift rod coupling spool.	Splines milled on leading and trailing corners (EPR K2-35). Incomplete engagement wore the shift rod spool splines (EPR K2-36).

Shortcoming	Suggested Corrective Action	Remarks
Lubricant leaked from winch drum because breather plug located below level plugs.	Improve assembly control.	Standard winch for M578 requires modification for XM806E1 application (EPR K2-51). Similar incident reported during M113 recovery vehicle test.
Repeative winch, winch-mount, fair-leader and fair-leader-mount bolts loosening from vehicle vibration.	Maintenance manual should require quarterly checks for mounting bolt tightness.	Checked periodically during test. Quarterly check necessary (EPR's 22, 43 (22-2), 67 (23-3)).
Operator not warned of impending damage to power pack components since view to driver's instrument panel obstructed.	Operator's manual should require a crew member to remain in the driver's compartment to monitor engine gages.	EPR K2-19.
Defective gasket caused hydraulic fluid leak from counterbalance valve.	Improve quality control.	Corrosive deposit found on gasket and valve interface gouged. Leaking started after 5.4 winch hours (EPR K2-11). Similar incident reported M113 recovery vehicle test (Reference 3, Appendix VII).
Hydraulic pump drive belts found broken.		Two of four belts failed when cooling fan drive belts caught in pump pulley (EPR K2-13).

Shortcoming	Suggested Corrective Action	Remarks
Hydraulic pump mounting screw 1/2 turn loose from vehicle vibration.	Provide locking washers on bolts.	Vibrated loose after 3395 miles and 562 winch hours (EPR K2-41).
Cracks evident on rear two welds for winch control valve bracket.	Provide stronger bracket and compatible weld.	Cracks found after 88.8 hours of winch operation (EPR K2-60). Welding and bracket modification as per ECP/EO E1134.
Weld cracks on forward vertical rib of hydraulic pump bracket.	Improve quality control.	Minimal weld penetration into parent metal (EPR K2-91).
Level wind floating pulley spoke cracks from cable side loading.	Provide pulley with thicker spoke ribs.	Cracks on all ribs on both sides of each spoke near the hub after 100.8 winch hours (EPR K2-80).
Excessive torque failed levelwind trunnion cap set screw.	Provide softer screw with only tip heat treated.	Failed the thickness of jam nut from top of screw (EPR K2-81). Similar incident reported during M113 recovery vehicle test.
Cable interfered with levelwind retaining plate spacer.	Relocate spacer one mounting hole lower.	EPR K2-9.
Levelwind shaft retaining collar set screws unable to hold pulley.	Provide set screw with a flatter head.	Set screws allowed collar to slide after 88.8 winch hours. Roll pin in each collar sheared (EPR K2-58).

Shortcoming	Suggested Corrective Action	Remarks
Fairleader tensioner handle struck mount and broke eye bolt.	Shorten approximately 1-3/4 inches to eliminate possible interference with mount.	Cheater bar required to operate tensioner handle so shorter handle would not change operational method (EPR K2-33).
Cable wore groove in fairleader bearing locking collar.		An 1/8-inch deep groove worn after 50.9 winching hours (EPR K2-23).
Left front fairleader hull channel mount weld crack.	Provide full length fairleader hull mount.	Cracked after 100.8 winch hours (EPR K2-63). Similar incident reported during M113 recovery vehicle test. One full channel provided in ECP/EO E1195.
Flat worn on fairleader tension roller and lower pulley from improper adjustment.	Improve assembly methods control.	EPR's K2-37 and -52.
Fairleader guide roller pilot hole worn.		Wear of 0.05 inch after 100.8 hours of operation (EPR K2-76).
Right hinge pin for right safety gate vibrated loose.	Replace roll pin hinge with bolt.	Two pins replaced. One after 50.9 hours, second after 37.9 hours. Vehicle vibration and gate slamming against ramp loosened pins (EPR's K2-30, -55 (30-2)). Bolt provided in ECP/EO D9968.

Shortcoming	Suggested Corrective Action	Remarks
Corners of stop light guards gouged from hook of spade positioning cable.	Eliminate interference by modifying guard.	Found gouged after 1423 miles (EPR K2-16). Guards modified as per ECP/EO D9787.
Center spade section slid rearward of stowed position and interfered with rear lifting eye.	Provide rear stop for stowed position.	Flat worn on spade. Strap foot man loop weld failed (EPR K2-87).
Weld crack in spade eye for ramp safety chain.	Improve weld control.	Cracked after 40.6 winch hours. Personnel walking on ramp impacted impact load on eye (EPR K2-17).
Spade stowage hook worn because bumper not sufficiently compressed.	Provide for an inspections of bumpers in operator's manual.	Wear evident after 1423 miles (EPR K2-14).
Inboard right spade pivot pin bushing loose.		Worked loose after 1423 miles (EPR K2-15).
Crane pump handle packing nut worked loose following hydraulic fluid to leak.	Provide locking feature for packing nut.	Leakage evident after 3 crane hours (EPR K2-47).
Defective O-ring allowed hydraulic fluid to stream from crane cylinder pressure relief plug.		Leakage started after 10.5 crane hours (EPR K2-48).

Shortcoming	Suggested Corrective Action	Remarks
Crane hydraulic release handle damaged during shipment.	Improve shipping stowage.	Damaged handle replaced (EPR's K2-3, -5 (3-2)).
Incorrect hand chain hoist capacity.	Provide two-ton capacity chain hoist or lower capability of crane to 1-1/2 tons.	Hoist capacity should be consistent with crane capacity (EPR K2-8). Crane capacity lowered as per ECP/EO D9846.
Auxiliary throttle control adjustment specifications incorrect to obtain desired winch line speed.	Maintenance manual should indicate the correct no-load engine speed for winch operations.	Original setting of 1800 rpm changed to 2700 rpm (EPR's K2-4 and -10 (4-2)).
Right rear fender and inboard weld cracked from loading during winch operations.	Provide stiffner in fender area.	(EPR K2-62). Similar incident reported during M113 recovery vehicle test.
Ramp center hinge weld cracked during towing operations.		Four-inch crack observed after 972 towed miles (EPR K2-49). Crack extended an additional 1-1/8 inches after a total of 2045 towing miles (EPR K2-84 (49s)).
Position of rear bilge pump outlet allows water to jettison against side spade and re-enter vehicle.	Provide deflector to direct water to side of vehicle.	(EPR K2-20). Similar shortcoming reported during M113 recovery vehicle test. Deflector provided in ECP/EO D9969.

Shortcoming	Suggested Corrective Action	Remarks
Cooling fan drive belts failed.		Failed belts caused hydraulic pump belt failure (EPR K2-13). Random failure downgraded to a shortcoming (EPR K2-12).
Right number one torsion bar failed.		Failed twice: first, after 1802 miles; second, after 2233 miles (EPR's K2-26 and -65 (26-2)).
Three shock absorbers replaced because of damage or leakage.		Right front shock replaced after 1802 miles and 2233 miles (EPR's K2-27 and -69 (27-2)). Left rear shock replaced after 3395 miles (EPR K2-40).
Drive sprocket teeth worn.		First set reversed after 2084 miles and replaced after additional 505 miles (EPR's K2-29 and -34). Second set reversed after 1431 operational miles and satisfactory until end of test (EPR K2-54).
Excessive back lash between generator drive pulley and shaft.		Noted during final inspection. Normal life of pulley exceeded by winch operational hours (EPR K2-71).
All rubber worn from roadwheel.		Left number four inboard roadwheel damaged after 4035 miles (EPR K2-66).

Shortcoming	Suggested Corrective Action	Remarks
Dirt on bearing surface allowed roadwheel housing seals to leak.		Left and right number one roadwheel seals leaking (EPR K2-68).
Right headlight beams burnt out and lens cracked.		Lens cracked after 1788 miles (EPR K2-25). Inoperative after 3753 miles (EPR K2-53).
Field of fire restriction for the cal .50 cupola machine gun with side spades in travel position.	Warn operator of firing hazard.	Round could penetrate however jacket could ricochet (EPR K2-38).
Maintenance package incomplete.		Missing OVE and maintenance manual (EPR K2-7).

3. Corrected Deficiencies and Shortcomings

Deficiency and Shortcoming	Corrective Action	Remarks
Three standard M113A1 pintle failures from towed loads over cross-country terrain.	Larger tow pintle (M548 type) tested and found satisfactory for 1000 miles.	Standard M113 pintle failures after 39, 59, and 247 towed miles (EPR's K2-24, -28 (24-2), and -31 (24-3)). New pintle required larger ramp hole (EPR K2-70). Larger pintle provided in ECP/EO D9969.

Deficiency and Shortcoming	Corrective Action	Remarks
Winch hydraulic fluid temperature warning light burned out.	Temperature gage installed to provide more positive means of checking hydraulic fluid temperature.	Filament found burnt after 55.3 hours (EPR K2-39). Temperature gage tested for only 41.1 winch hours (EPR K2-44). Gage provided for in ECP/EO D9762.

APPENDIX V - MAINTENANCE EVALUATION

Summary of Incidents

Vehicle:	Towing Miles at Time of Incident	Odometer Reading at Time of Repair	Vehicle Hours in Maintenance	Organizational Maintenance Man-Hours
Initial Inspection - tightened steering brakes, tightened oil line left side steering difficult.		147	0.5	1.0
Replaced right headlight sealed beam unit.		683	0.2	0.2
Replaced No. 5 left roadwheel access cover and static suppressor spring.		856	0.4	0.4
Replaced two cooling fan belts.		1501	0.5	0.5
Replaced towing pintle hinge for top jaw.	39	1928	0.5	0.5
Replaced towing pintle (shaft failed).	98	1988	0.5	0.5
Replaced right front bump stop.		1988	0.3	0.3
Replaced right front shock absorber.		2177	0.5	0.5
Removed track block (right).		2283	0.5	0.8
Replaced pintle (hinge pin sheared).	345	2283	0.5	0.5
Removed one track block (left) replaced left front shock absorber.		2312	1.3	1.6
Replaced No. 1 torsion bar.		2465	1.5	3.0
Removed two track shoes from each track.		2726	0.8	1.6
Replaced both sprockets and sprocket cushions.		2726	2.5	5.0

Vehicle:	Towing Miles at Time of Incident	Odometer Reading at Time of Repair	Vehicle Hours in Maintenance	Organizational Maintenance Man-Hours
Replaced left shock absorber.		2726	0.5	0.5
Replaced No. 1 left road arm seals.		2726	1.0	1.1
Adjusted fan belts.		3008	0.3	0.3
Replaced No. 5 right rear roadwheel (wear pad worn out).		3352	1.0	2.0
Replaced broken right track block.		3519	1.0	1.3
Replaced left rear shock absorber.		3519	0.5	0.5
Replaced 7 track blocks.		3535	1.6	3.5
Replaced 14 track blocks.		3789	3.6	7.4
Replaced right head light.		3885	0.2	0.2
Replaced front bilge pump (inoperative).		4163	0.7	0.7
Replaced right front torsion bar (broken).		4163	1.5	3.0
Replaced right front shock absorber.		4175	0.5	0.5
Totals			22.6	37.4

Winch:	Winch Hours	Odometer Reading at Time of Repair	Vehicle Hours in Maintenance	Organizational Maintenance Man-Hours	General Support Maintenance Man-Hours
Adjusted winch levelwind floating pulley spacer, one hole lower.	0.2	1484	0.2	0.2	
Adjusted throttle linkage for winch operation.	4.7	1492	1.0	1.0	
Counterbalance valve, top cover gasket leaking, made and installed new gasket.	5.4	1493	0.7	1.0	
Replaced four hydraulic oil pump belts.	8.7	1501	0.5	0.5	
Adjusted side spade bumper stops.		1563	0.4	0.4	
Replaced hinge pin in right safety gate.	50.2	2224	0.2	0.2	
Removed hydraulic motor, and removed sharp edges from shifting sleeves.	51.8	2417	0.5	1.0	
Replaced worn fairieader pulley (flat spot).	51.8	2729	0.5	0.5	
Replaced winch cable chain link, and fairleader tensioner handle.	51.8	2819	0.5	0.5	
Tightened hydraulic pump mounting bolts.	56.2	3535	0.2	0.2	
Replaced winch cable.	57.1	3788	2.0	4.0	
Repaired winch, replaced 2nd and 3rd stage planetary gear train, replaced lower pulley in fairleader.	59.8	3789	15.7		32.0
Adjusted governor control linkage.	61.3	4162	0.2	0.2	
Totals			22.6	9.7	32.0

Hand Operated Hydraulic Crane:	Crane Hours	Odometer Reading at Time of Repair	Vehicle Hours in Man-Hours	Organizational Maintenance Man-Hours
Tightened pump handle packing.	3	3789	0.1	0.1
Replaced O ring in hydraulic cylinder relief plug.	10.5	3789	0.5	0.5
Totals			0.6	0.6

Maintenance Data Summary

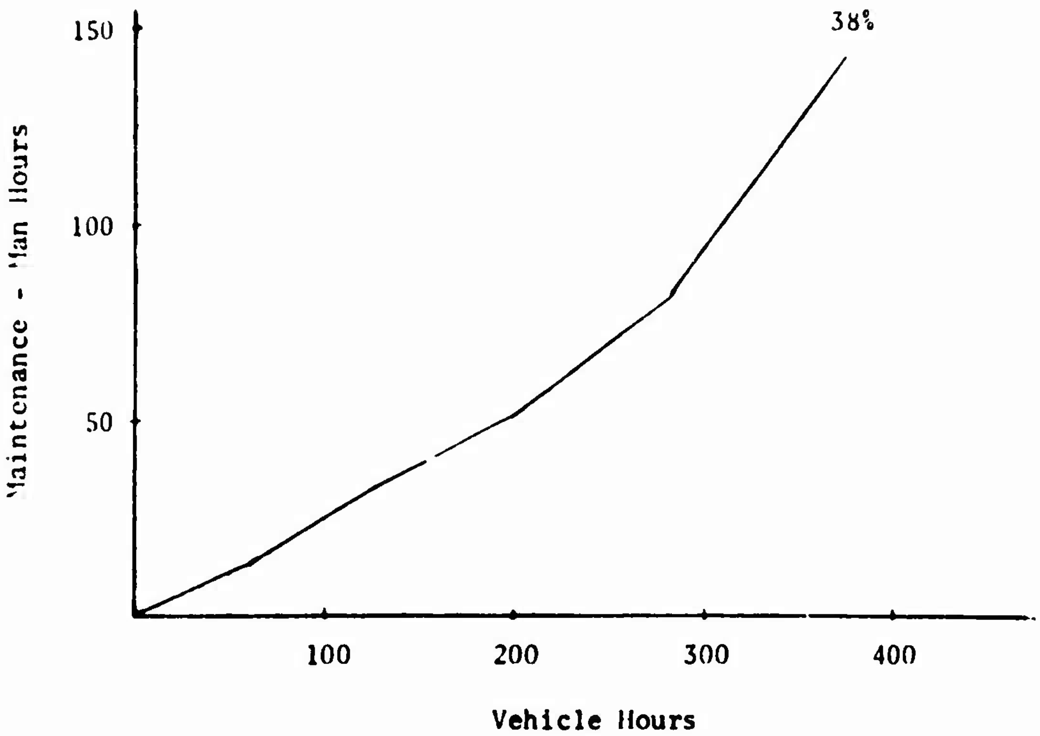
1. Velocity - Average test speed, mph	14.45
2. Reliability, vehicle hours	
a. Time in use	392.2
1) Vehicle	279.3
2) Winch	100.9
3) Crane	12.0
b. Maintenance, 100%	99.6
1) Scheduled maintenance	53.6
2) Unscheduled maintenance	46.0
c. Per cent of time in use	79.7
d. Per cent of time in maintenance	20.3
1) Per cent of time in scheduled maintenance	10.9
2) Per cent of time in unscheduled maintenance	9.4
e. Mean time between failures (MBF)	
1) Organizational	10.32
2) Field	[a] -
f. Mean time between scheduled maintenance	
1) Organizational (driver)	1.4
2) Organizational (other)	17.05
3. Amount of maintenance, man-hours	
a. Maintenance man hours	
1) Scheduled maintenance man hours	68.6

[a]General support maintenance was required once for winch rebuild after 59.8 winch hours and 3649 vehicle miles.

2) Unscheduled maintenance man hours	79.7
a) Vehicle	37.4
b) Winch	41.7
c) Crane	0.6
b. Maintenance man hour per operating hours	.38
1) Organizational (driver)	.07
2) Organizational scheduled	.11
3) Organizational unscheduled	.12
4) Direct and general support	.08
c. Maintenance man hours per 100 miles	3.68
4. Maintainability, vehicle hours	
a. Average length of each stoppage	
1) Organizational (driver)	0.10
2) Organizational scheduled	1.12
3) Organizational unscheduled	0.78
4) Direct and general support	16.0
b. Total vehicle downtime per operating hour	0.12
c. Total vehicle maintenance hours per operating hour (not to be confused with maintenance man hours)	0.25
5. Vehicle operation	
a. Test course mileage	
Gravel	944
Paved	942
Level cross-country	1068
Hilly cross-country	1081
Total	4035
b. Winch operation	100.9
c. Crane operation	12.0

Engineering Test
Maintenance versus Operation
for Recovery Vehicle, Full
Tracked, Light Armored,
XM806E1

USA Reg. No. 12C27468



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DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

20 NOV 1968

AMSTE-BB
1-7-2625-09
1-7-2625-34

SUBJECT: Test Directive, Engineering and Service Tests of Vehicle Recovery Kit and Crane for Carrier, Personnel, Full-Tracked, Armored, M113A1, RDT&E Project No. 1G564605D410

Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT
President, U. S. Army Armor and Engineer Board, ATTN: STEBB-ML-T, Fort Knox, Kentucky 40121

1. Reference is made to:

a. Confidential Letter, AMSTE-BB, HQ, USATECOM, 18 December 1967, subject: Test Directive, Military Potential Test of Vehicle Recovery Kit and Crane for Carrier, Personnel, Full-Tracked, Armored, M113 (U).

b. Confidential Message 07028, MACJ342, COMUSMACV, 5 March 1966, subject: M113 Vehicle Recovery Kit (U), (inclosure 1 to reference a).

2. Background: ENSURE 56 (reference b) describes the requirement for a recovery vehicle kit for the M113 armored personnel carrier. An auxiliary crane was also proposed as an accessory item. ENSURE 56 was subsequently expanded (ENSURE 134) to include the installation of the recovery vehicle kit on the M113A1. Although military potential tests have been conducted on the M113 (gas) version of the recovery kit and crane, engineering and service tests of the M113A1 (diesel) version are required, as type-classification of the diesel version is currently planned.

3. Description of Materiel:

a. Test items include the vehicle recovery kit and auxiliary crane as adapted to new M113A1 armored personnel carriers. The vehicle recovery kit consists of components and support members for a hydraulically driven winch, self-aligning fair lead assembly with cable tensioner, guards, manually operated spades, recovery tools and equipment, and stowage facilities. A listing of the major differences between the M113 and M113A1 versions of the recovery kit and crane is provided at inclosure 1.

b. The nomenclature, Recovery Vehicle, Full-Tracked: Light Armored (M113A1) XM806E1 has been tentatively assigned to the M113A1 when equipped with the recovery kit and crane. However, this nomenclature should not be used in titles of correspondence and reports until such time as you are notified to the contrary.

4. Test Objectives: The objectives of this test program are to determine the suitability for US Army use of the vehicle recovery kit and auxiliary crane when installed on the M113A1. As a minimum, the following determinations are required:

a. Suitability of the vehicle recovery kit for use as described in reference b.

b. Suitability of the auxiliary crane for handling and placement of repair items.

c. Performance, durability, and maintainability of the vehicle recovery kit and crane.

d. Effects of the vehicle recovery kit and crane on basic chassis durability, performance, and amphibious capabilities.

e. Utility of layout and configuration of crew compartment; adequacy of recovery tools and equipment and stowage provisions.

f. Any possible safety hazard or adverse human factors associated with the deisgn of the M113A1 recovery vehicle.

g. Adequacy of the maintenance test package.

5. Responsibilities:

a. Under USATECOM Project No. 1-7-2625-09, Commanding Officer, Aberdeen Proving Ground is responsible for the planning, accomplishment, and reporting of subject engineering test and the preparation of safety release recommendations.

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20 NOV 1968

AMSTE-BB
SUBJECT: Test Directive, Engineering and Service Tests of Vehicle Recovery Kit and Crane for Carrier, Personnel, Full-Tracked, Armored, M113A1, RDT&E Project No. 1G564605D410

b. Under USATECOM Project No. 1-7-2625-34, President, US Army Armor and Engineer Board is responsible for the planning, accomplishment and reporting of subject service test. Maintenance evaluation as described in USATECOM Regulation 750-15 will also be conducted on items peculiar to the M113A1 recovery vehicle.

6. Coordination: In view of the short time available prior to delivery of the test items and the fact that your M113 recovery vehicle military potential test plans were previously coordinated formally with USACDC and USCONARC, informal coordination of your test plans will not be accomplished prior to submission to this headquarters for approval.

7. Special Instructions:

a. Both vehicles are scheduled to be shipped by truck from the contractor's plant on 22 November 1968. They should arrive at your agencies during the week of 1 December 1968. Testing should begin immediately upon receipt of the test items.

b. As a minimum, testing at each agency should include 4000 miles of vehicle operation, 100 hours of winch operation, swimming, limited recovery equipment, crane, and vehicle performance testing, evaluation of stowage, and maintenance evaluation. Emphasis should also be placed on evaluation of the modifications listed in inclosure 1. Maximum use of information and test results gained from the previously conducted military potential tests of the M113 recovery vehicle should be made to minimize unnecessary duplication of work already completed. Data obtained from the M113 tests may be included in the final reports of test if such data is adequately identified and appropriate to the M113A1 recovery vehicle.

c. Detailed requirements or specifications for the M113A1 recovery vehicle do not currently exist. Attempts are being made to obtain test criteria from USARV and USACDC. These criteria will most likely be stated in terms of degree of allowable degradation in the performance and durability of the basic M113A1 vehicle.

d. Maintenance manuals (operator's organizational, and lubrication order), draft equipment stowage list, special tools, and drawings are to be provided before or concurrently with arrival of the vehicles.

Spare parts support will be provided on items peculiar to the M113A1 recovery vehicle. Other standard parts are to be drawn from supply channels. A manufacturer's technical representative will also be available for the duration of testing.

e. Communications equipment (AN/VRC-47, AN/VIC-1, and installation kits) are being requisitioned for the USARENBD vehicle.

f. Funds in the amount of are on hand at APG under AMCMS Code 5551.12.21500. An additional is being provided by AMC.

g. Priority conflicts that arise between subject test and the tests of the bulldozer kit for the M113A1 (USATECOM Project Nos. 1-7-2625-10 and -35) will be resolved by granting preference to subject test.

h. Significant events which affect either the conduct or the timely completion of this test will be reported to this headquarters and to USATACOM. Contacts are:

(1) HQ, USATECOM, Mr. McCormack, APG ext 4996

(2) HQ, USATACOM, Mr. Hutten, ATAC ext 28250

8. Test Plans and Reports:

a. Test plans are to be submitted to this headquarters for approval by 9 December 1968.

b. Interim reports are to be submitted at the end of each 1000 miles of testing, giving results of the preceding segment of testing. These reports may form the basis for recommendations by higher headquarters pertaining to the procurement of limited quantities of M113A1 recovery vehicles.

c. Active testing is to be completed as soon as possible but no later than 16 May 1969.

d. Distribution for the test plan and for each form of report is specified in inclosure 2.

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20 NOV 1968

AMSTE-BB
SUBJECT: Test Directive, Engineering and Service Tests of Vehicle Recovery Kit and Crane for Carrier, Personnel, Full-Tracked, Armored, M113A1, RDT&E Project No. 1G564605D410

9. Safety: A safety statement is being forwarded by USATACOM under separate cover. APC testing should be scheduled so as to produce, as a minimum, recommendations for a conditional automotive safety release within 15 days after receipt of the test item.

10. Security: Mission requirements, using forces, production quantities, and delivery dates are classified Confidential. The test item and test results are unclassified when not compared to classified requirements.

FOR THE COMMANDER:

/s/ John P. Wheeler, Jr.
/t/ JOHN P. WHEELER, JR.
Colonel, GS
Dir, Arm Mat Test Dir

3 Incl
1. Major differences, M113/M113A1 RV
2. Distribution List
3. TSMS Form

Copies furnished: w/incl 1
CG, USAMC, ATTN: AMCRD-GV
USACDC LnO, USATECOM
USMC LnO, USATECOM
PO, M113, ATTN: AMCPM-M113, USATACOM
CG, USATACOM, ATTN: AMSTA-RET

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LT Ramig/pgl/3230

STEAP-MT-TU

SUBJECT: Safety Release Recommendation for Recovery Vehicle, Full Tracked: Light Armored (M113A1) XM8060E1, USATECOM Proj. No. 1-7-2625-09

Commanding General
U.S. Army Test and Evaluation Command
ATTN: AMSTE-BB

1. Reference: Letter, AMSTE-BB, dtd 20 November 1968, Subject: Test Directive, Engineering and Service Tests of Vehicle Recovery Kit and Crane for Carrier, Personnel, Full-Tracked, Armored, M113A1, RDT&E Project No. 1G564605D410.

2. As directed by paragraph 9, of reference, a safety evaluation was conducted to disclose any existent or potential operating and personnel hazards.

3. The characteristic limitations listed in the evaluation are based on test data and observations made during vehicle performance tests. Results are listed below:

a. Gradeability and Side Slopes

Stability, handling, and engine operating characteristics were satisfactory in both directions on side slopes up to and including 30% and longitudinal slopes up to and including 60%. The test vehicle was capable of towing a loaded M113A1 up a 20% slope. When towing a loaded M113A1 down the 30% slope, steering control became difficult. Slopes in excess of 30% should not be descended with a towed load and descending slopes from 20% to 30% should only be negotiated with extreme caution.

b. Steering

Minimum clearance turning diameter of the XM806E1 was 46.5 feet. With an unloaded M113A1 in tow, a clearance diameter of 53.5 feet was measured. A fully loaded M113A1 (total weight of 23,400 pounds) in tow required a turning diameter of 56.4 feet. The clearance diameter with towed load was limited by tow bar interference with the rear fenders of the XM806E1.

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c. Maximum Speeds

The test vehicle was able to achieve a maximum speed of 41 mph. With a fully loaded M113A1 in tow the maximum speed attainable was 23 mph.

d. Braking

The average stopping distance of the test vehicle and of the test vehicle towing a fully loaded M113A1 for various speeds is listed as follows:

Road Speed, mph	Average Stopping Distance, ft. W/O Towed Load	Average Stopping Distance, ft. W/Towed Load
10	7	14
20	27	60
30	77	--

Since the stopping distance with a towed load was at least twice that of the independent vehicle, towing operations should be conducted at a slower speed (approximately three quarters) for the same operating conditions of the vehicle without a towed load.

The brakes satisfactorily held the vehicle in either an ascending or descending attitude on the 60% longitudinal slope.

With a loaded M113A1 in tow, the XM806E1 brakes held satisfactorily in a descending attitude on the 30% slope but were marginal when facing up the 30% slope.

e. Center of Gravity

The center of gravity of the test vehicle was approximately five inches higher than that of the basic M113A1 carrier. The same cautions should be exercised when negotiating obstacles as with the M113A1.

f. Limits of Vision

Thw winch operator's limits of vision were determined from a position in the middle of the winch operator's seat. With the ramp lowered, the normal vision area extended from 10° left to 40° right of the operator's vertical center line. The maximum vision area extended from 25° left to 50° right of the operator's vertical center line.

g. Weapon Fields of Fire

The spades in travel position created a weapon firing and sighting restriction for approximately 10° of azimuth at two locations over

the rear of the vehicle. The gun sight line must be elevated approximately 1.5° above the horizontal firing line to avoid the spades.

h. Winch Operations

The relief valve limited maximum hydraulic fluid pressure to 1550 psi, and single line cable pulls to the following:

Cable Layer	Maximum Cable Pull, lbs. Low Range	High Range
1 (bare drum)	20,900	4,950
2	19,400	4,250
3	17,750	4,000
4	16,000	3,500
5	14,800	3,150

Although the bare drum line pull in low gear exceeded the manufacturer's rated load capacity by 900 pounds, the maximum pull attainable was well below the 33,200 pound new cable breaking strength.

The winch brake was capable of holding the maximum line pull for each cable layer.

To insure safety to operating personnel, the open mesh protective guard over the cable from the fair leader to the winch drum, and the two ramp safety gates should be secure and in place before any line pull is attempted. The guard prevents personnel in the vehicle from catching limbs or clothing in the winch, level wind or winch cable and also confines the cable in case it breaks. The two safety gates protect personnel in the vehicle from flying objects should a rigging or cable failure occur during winch operations.

Personnel outside the vehicle should be positioned sufficiently clear of the cable to avoid injury in the event of cable failure.

When lowering the side ground spades, personnel should stand clear of spade arc of travel during release.

A potential safety hazard exists when pulling with a two part line using either of the two vehicle cable anchors because the vehicle can be tipped sideways. Heavy pulls to the side should be avoided when using a two part line.

The auxiliary throttle control should be returned to the idle position immediately after winch operation. This will prevent unexpected vehicle movement should the range selector be moved from neutral with the auxiliary throttle on.

To avoid damage to the winch the operator should not attempt to shift gears with the winch in operation.

The operator should frequently observe the cable through the fair leader over the level wind and onto the winch drum to assure proper cable spooling.

The cable should not be payed-in without sufficient load if the vehicle is canted. The fair leader tension control must be in the cable pay-in position whenever paying-in cable.

To prevent damage to hydraulic components, the winch should not be operated for extended periods of time with the hydraulic fluid high temperature warning light on.

After a hose, valve, or other hydraulic component is disconnected or replaced, the winch hydraulic system should then be operated with the winch in neutral and the control valve cycled to circulate fluid and release any entrapped air from the system.

The safety chain should be attached from the right ground spade (down position) to the eye on the ramp (down position) whenever the spades are embedded and the ramp is lowered. The chain prevents damage to the ramp lifting cylinder.

To prevent equipment damage, low range should be used to pay-out cable under load (not neutral) and a minimum of two wraps should always be retained on the winch drum.

Appropriate gloves should be worn when handling cable. Rusty or broken strands can cause serious injury.

The engine should be shut off prior to repair or replacement of any component of the hydraulic or winch system and the control valve should be cycled to relieve system pressure.

Operating personnel should be familiar with FM20-22, particularly chapter three, to be aware of safety hazards inherent when operating this type of vehicle.

i. Crane Operations

The crane was capable of lifting and holding for one hour, without drift, a 4000 pound load. The manual effort required on the pump lever ranged from 40 pounds, to lift the weight off the ground, to 80 pounds, near maximum elevation.

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A cheater bar should not be used on the chain hoist handle because overloading, by the use of additional leverage, will result in damage to equipment and possible injury to personnel.

The lifting chain should be examined frequently to assure the chain links are sound and fit the boom properly.

The utility release valve should be used to lower loads (not the auxiliary release valve). The utility release valve provides a controlled lowering rate.

4. Inappropriate weather conditions prohibited amphibious operations. Any safety hazards disclosed during amphibious operations will be indicated by a supplement to this correspondence.

FOR THE COMMANDER:

/t/ R. P. WITT
Associate Director
Materiel Test Directorate

DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-BB

8 FEB 1969

SUBJECT: Engineering and Service Tests of Recovery Vehicle, Full-Tracked, Light Armored (M113A1) XM806E1, RDT&E Project No. 1G564605D410 (ENSURE 134)

Commanding General, US Army Materiel Command, ATTN: AMCRD-GV, Washington, D. C. 20315
Commanding General, US Army Combat Developments Command, ATTN: CDC LnO, USATECOM, Aberdeen Proving Ground, Maryland 21005
Commanding General, US Continental Army Command, ATTN: ATIT-RD-MD, Fort Monroe, Virginia 23351

1. Transmitted herewith are test plans for subject tests as prepared by Aberdeen Proving Ground and the US Army Armor and Engineer Board. These plans have been approved with the following exceptions:

a. Paragraph 2.17.3.7 of the Aberdeen Proving Ground test plan will be expanded to include the determination of hydraulic oil temperature/time characteristics at 50% load at each spool layer as well as 100% maximum design load. Towed load operation described in paragraph 2.19.3 will be reduced from 2000 miles to 1000 miles.

b. Maintenance ratios and pertinent reliability and maintainability characteristics described in paragraphs 2.9 and 2.10 of the Armor and Engineer Board test plan will be computed separately for the standard M113A1 components and the vehicle recovery kit, as well as the XM806E1 vehicle in total.

2. Detailed requirements or specifications for the XM806E1 have not been provided. Therefore, this headquarters has been compelled to arbitrarily assign limits of testing: 4000 miles of vehicle operation, 100 hours of winch operation, and 12 hours of full-load crane operation. Performance of the XM806E1 will be compared to requirements contained in purchase descriptions for the M113A1 and P30 winch and to actual operation of the M113A1.

3. It is understood that the XM806E1 is to be type classified upon completion of testing. However, the test program defined in the inclosed plans has been restricted to the determination of US Army suitability in

3 FEB 1969

AMSTE-BB
SUBJECT: Engineering and Service Tests of Recovery Vehicle, Full-Tracked, Light Armored (M113A1) XM806E1, RDT&E Project No. 1G564605D410 (ENSURE 134)

temperate environments because of test time and hardware limitations. Determination of suitability for world-wide usage will require a test program of greater depth.

4. Comments and/or concurrence are requested. Informal coordination with USACDC agencies and USCONARC schools was not accomplished prior to submission to this headquarters for approval.

FOR THE COMMANDER:

JOHN P. WHEELER, JR.
Colonel, GS
Dir, Arm Mat Test Dir

2 Incl
as (USAMC 2 cys)
(CDC LnO 12 cys)
(USCONARC 4 cys)

Copies furnished:
CG, USAMC, ATTN: AMCMI 1 cy
AMCSU 1 cy
AMCMA 1 cy
AMCPO-M113 (Warren) 2 cys
CO, APG, ATTN: STEAP-MT-TU w/o incls
PRES, USAARENBD, ATTN: STEBB-ML-T w/o incls

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

7 APR 1969

AMSTE-BB 2625-09/-10/-34/-35

SUBJECT: Final Drive Sprocket Bolt Modification

Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT-TU
President, US Army Armor and Engineer Board, ATTN: STEBB-ML, Fort Knox, Kentucky 40121

1. Reference is made to Message 3-12680, AMSTA-RET.8, USATACOM, 27 Mar 69, subject: ST of M113A1 Bulldozer, Loose Sprocket Drive Bolts (copy inclosed).

2. Lockwasher installation and torqueing procedures requested in referenced message are hereby authorized for the XM806E1 and M113A1 bulldozer vehicles at your agencies. Adequacy of modifications and torque history are to be included in your final reports of test.

FOR THE COMMANDER:

1 Incl
as

JOHN P. WHEELER, JR.
Colonel, GS
Dir, Arm Mat Test Dir

Copy furnished: w/o incl
CG, USATACOM, ATTN: AMSTA-RET.8

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RTTUZYUW RUEBWMA2700 0411744-UUUU--RUEBEAA.

ZNR UUUUU

11 FEB 69
ACTION: MTD
INFO: ISD
Safety

R 071930Z FEB 69

FM CG USATECOM WARREN MICH

TO RUEBEAA/CG USA TEST & EVALUATION COM APG MD

INFO RUEBEAA/CO APG MD

RUWTFOA/PRES US ARMOR BD FT KX KY

BT

UNCLAS 2-12667 FOR AMSTE-BB, R. MC CORMACK

INFO FOR: STEAP-MT-TU, RAMIG, STEBB-MC-SN BARNABY, STEBB-AR, MUELLER, FROM AMSTA-RET.8, H. HUTTEN, SGD BY AMSTA-RET.8, E. DARSON.

SUBJECT: ET/ST FOR XM806E1 RECOVERY VEHICLE AND M113A1 BULLDOZER.

FOLLOWING ARE INSTRUCTIONS RELATIVE TO CURRENT TESTING OF FOUR PILOT VEHICLES:

1. XM806E1 (PILOTS NUMBER 1 AND NUMBER 2, APG VEH 12C27468, KNOX VEH 12C27968)

A. INSTALL HYDRAULIC TEMPERATURE GAGE ON TANK UPON RECEIPT OF HARDWARE AND INSTRUCTIONS FROM FMC.

2. XM113A1 DOZER (PILOT NUMBER 1, APG VEH 12C27868)

A. INSTALL NEW 7-C UNIVERSAL JOINT FURNISHED BY FMC

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PAGE 2 RUEBWMA2700 UNCLAS

TO REPLACE FAILED 6-C JOINT.

B. UPON RECEIPT OF HARDWARE AND INSTRUCTIONS FROM FMC, REPLACE PRESENT DOZER BLADE WITH NEW HALF BLADE AND HALF OF SPARE BLADE. MR. M. SNAVELY, FMC FIELD REP, WILL SHIP UNUSED HALF SPARE BLADE TO FT KX FOR INSTALLATION ON PILOT NUMBER 2.

C. SWIMMING CAPABILITY IS PRESENTLY CONSIDERED MARGINAL AT FULL COMBAT LOAD. DO NOT CONDUCT SWIMMING OPERATIONS UNLESS TEST PLAN AND VEHICLE WEIGHT ARE DISCUSSED WITH USATACOM PROJECT ENGINEER.

3. XM113A1 DOZER (PILOT NUMBER 2, KNOX VEH 12C27068)

A. USE CURRENT 6-C UNIVERSAL JOINT UNTIL FAILURE, THEN REPLACE WITH NEW 7-C JOINT FURNISHED BY FMC.

B. UPON RECEIPT OF HARDWARE AND INSTRUCTIONS, REPLACE PRESENT DOZER BLADE WITH NEW HALF BLADE FROM FMC AND HALF BLADE FURNISHED BY APG.

C. SAME AS ITEM 2C PRECEDING

BT

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DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-BB 2625-09/-10 27 MAY 1969

SUBJECT: Recovery Vehicle, Full Tracked: Light Armored (M113A1) XM806E1

Commanding Officer
Aberdeen Proving Ground
ATTN: STEAP-MT-TU

1. Reference:

a. Letter, AMSTE-BB, HQ, USATECOM, 25 February 1969, subject as above.

b. Letter, STEAP-MT-TU, Aberdeen Proving Ground, 7 March 1969, subject: Cost Estimates: XM806E1 Recovery Vehicle and XM11 Bulldozer Kit USATECOM Project Numbers 1-7-2625-09, 10.

2. Authorization is granted to operate in excess of the directed 4,000 miles in order to conduct the additional 1,000 mile test of the modified towing pintle (M548 type).

FOR THE COMMANDER:

/s/ John P. Wheeler, Jr.
/t/ JOHN P. WHEELER, JR.
Colonel, GS
Dir, Arm Mat Test Dir

APPENDIX VII - REFERENCES

1. Specification, MIL-C-46782A(MO), 14 October 1963, Carrier, Personnel, Full-Tracked; Armored, M113A1.

2. Purchase Description, ATPD-2033A, 19 May 1969, Recovery Vehicle, Full-Tracked: Light Armored, XM806 and XM806E1.

3. Ramig, H. J., Military Potential Test of Recovery Kit and Crane for Carrier, Personnel, Full-Tracked, Armored, M113, Aberdeen Proving Ground. Report No. DPS-2961.

4. Hylbert, S. L., Preproduction Test of Carrier, Personnel Full-Tracked, Armored, M113A1, Pilot No. 1, Aberdeen Proving Ground. Report No. DPS-1238.

5. Ramig, H. J., Test Plan on Engineering Test of Recovery Vehicle, Full-Tracked, Light Armored (M113A1), XM806E1, December 1968.

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3. REPORT TITLE

ENGINEERING TEST OF RECOVERY VEHICLE, FULL-TRACKED, LIGHT ARMORED (M113A1) XM806E1

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Final Report 17 December 1968 to 3 June 1969

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10. DISTRIBUTION STATEMENT

This document may be further distributed by any holder only with specific prior approval of Project Manager, M113, ATTN: AMCPM-M113.

11. SUPPLEMENTARY NOTES None. The XM-806E1 recovery vehicle is an M-113A1, APC modified for recovery of disabled vehicles comparable in weight to the M-113A1.	12. SPONSORING MILITARY ACTIVITY Proj Mgr, AMCPM-M113

13. ABSTRACT

An engineering test of the XM806E1 recovery vehicle was conducted at Aberdeen Proving Ground (APG) from 17 December 1968 to 3 June 1969. The purpose of the test was to determine the performance, suitability, durability, safety, and maintainability of the vehicle; and whether or not any degradation was realized to the basic M113A1 armored personnel carrier. The vehicle was scheduled for operation at APG for 4000 vehicle test miles, of which 1000 were with an M113A1 in tow. Also, 100 winch operating hours and 12 crane operating hours were conducted. Poor quality in manufacturing was responsible for a winch gear-train failure after 59.8 winch hours. Several additional defects were disclosed that were a recurrence of defects reported during the M113 recovery vehicle test. The durability of the standard M113A1 tow pintle was unsatisfactory for the towing test phase. An M548-type pintle was later evaluated for 1000 miles and found satisfactory. Operational hazards were disclosed for vehicle operation with an M113A1 in tow. It was recommended that the operator be warned of possible operational hazards. It was further recommended that winch quality-acceptance standards be increased.

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Recovery vehicle, armored						
Winch, vehicle mounted						
Crane, vehicle mounted						
M113A1, modifications to						